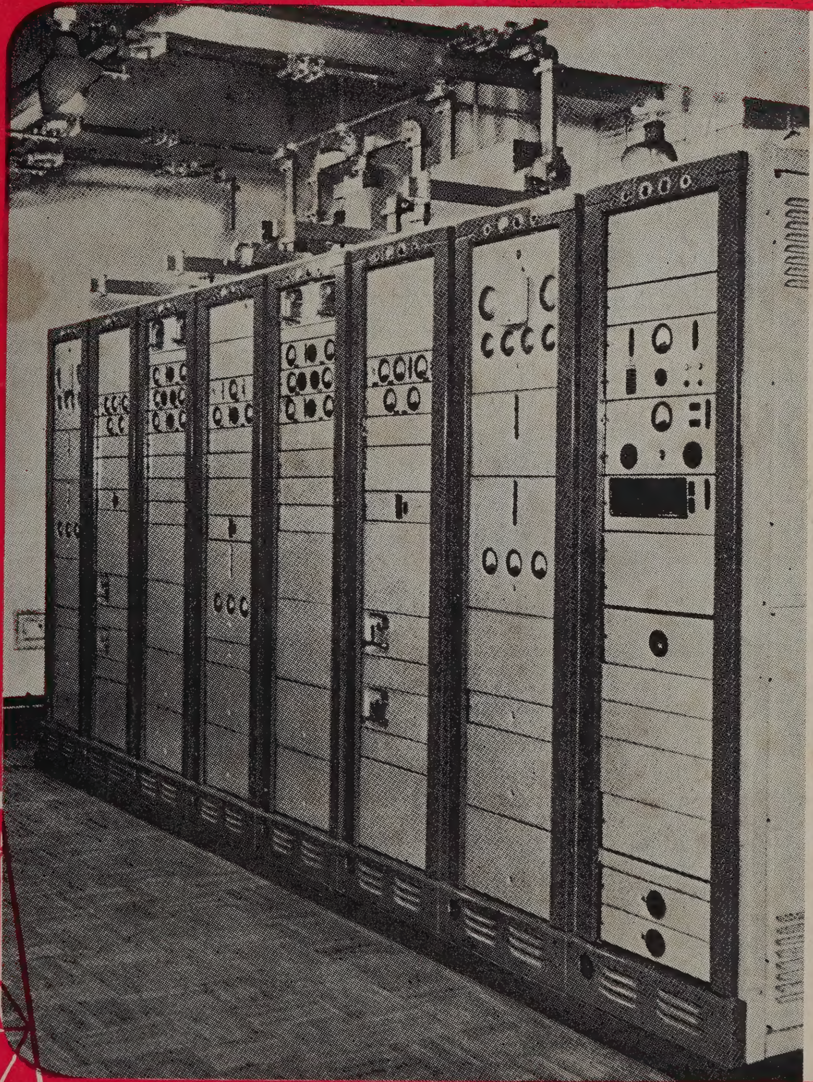
RADIO and ELECTRONICS

ELECTRICITY —— COMMUNICATIONS —— SERVICE —— SOUND



In This Issue:

Power Supply for a High-powered Amplifier

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A New Circuit for a C.R.T. Time-Base

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Using the WWV Standard Frequency Broadcasts

March, 2nd, 1953 VOL. 8, NO. 1

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Radio and Electronics

COVER PICTURE
this month illustrates some of the equipment racks belonging to a microwave TV relay station, and gives a good idea of the size and complexity of the gear needed for this apparently simple job.

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Contents

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A NEW RADIO HAZARD

In one of our American contemporaries, which we were reading the other day, there is an account of an accident, involving explosives, which were proved to have been detonated by radio waves! In case this may look like a tall story, it may be as well to recount the circumstances. The accident took the form of an explosion, which wrecked a small vessel in the Gulf of Mexico. The ship had been engaged in seismological surveying of the sea-bed, in the course of prospecting for oil. This technique, of creating man-made earthquakes by setting off small explosions, and measuring the times of arrival of the shock-waves at various strategically situated receiving points, is quite well known, and has been used in most countries, including New Zealand, so that the story about to be told is one which can be of vital interest to anyone using explosives in the vicinity of a radio transmitter. Rather would it become the duty of anyone operating a radio transmitter in the neighbourhood of work involving the use of explosives to give warning of the danger, shoud there be any. However, to proceed with the story.

The mysterious explosion on board the small ship was traced to the setting off of the stock of detonators on the vessel, presumably by its own radio transmitter, and the supplier of the explosives being used was sufficiently impressed by the occurrence to carry out an investigation into the problem of detonators being set off by radio. There is nothing mysterious in the occurrence. Detonators are normally fired by a spark, or by the heat of an electric current, so that where explosive has been put in position, and the detonating circuit completed, there must always be a danger of radio frequency currents, induced on the detonator wiring, of setting off detonators prematurely. The American detonators referred to in the article require a current of between .25 and 0.5 amps to set them off, so that given the right conditions, it is by no means impossible or even unlikely that a current of this magnitude could be induced in the wiring through the agency of a nearby transmitter. Experiments undertaken by the explosives company indicated that for transmitters of various powers, the following range of distance between the detonator wiring and the transmitting aerial could be reckoned safe.

Transmitter Power	Distance in Feet.	Transmitter Power	Distance in Feet.
5– 25 w. ..	100	1– 2.5 kw. ..	1,000
25– 50 w. ..	150	2.5– 5 kw. ..	1,500
50– 100 w. ..	220	5– 10 kw. ..	2,200
100– 250 w. ..	350	10– 25 kw. ..	3,500
250– 500 w. ..	450	25– 50 kw. ..	5,000
500–1000 w. ..	650	50– 100 kw. ..	7,000

Of course other things enter into the question whether a given transmitter constitutes a hazard in a certain case. Of some importance is the frequency. Low-frequency or broadcast stations are most likely to be dangerous, because there is then more likelihood of standing waves, set up on the detonator wiring, exhibiting a current loop at or near the detonators. For instance, if the detonator is at the end of a run of wire which is approximately a quarter of a wavelength long at the frequency of the transmitter, there is likely to be a high R.F. current at the danger point. Similarly, detonators at the centre of wires about half a wavelength long might be dangerous.

At high or very high frequencies, the possibility of trouble is very much reduced, because the power is usually quite low, relatively speaking, and because of such mitigating circumstances as directional transmission.

In any case, where trouble might possibly be encountered, a simple test can easily be applied. A 150 ma. dial lamp can be connected in place of each detonator when the wiring has been placed in position. Should any of the lamps show the slightest sign of glowing, then connecting the caps would be dangerous, and blasting should not be attempted unless the offending transmitter is prevented from operating.

Needless to say, it would be a very wise precaution never to store detonators in a building where there is a radio transmitter, even of low power.

The high explosives themselves, such as dynamite or gelignite, are not affected directly by R.F. radiation, since in general, they cannot be detonated except by shock.

A NEW TYPE OF DRY CELL

The old-fashioned dry Leclanche-type cell, which has served the radio industry so well for so long has shown surprisingly few modifications over a period of many years. The greatest advances made have been in the physical form of the cells, enabling more active material to be packed into a small space. Improvement in this direction has given us quite spectacular improvements in performance, when judged by milliampere-hour capacity per pound weight, and, just as much as the development of miniature valves, has made it possible for really small portable receivers to be designed. There is still room for improvement, however, because the reduction in the size of dry batteries has really been carried a little too far, in that these same miniature receivers suffer from a need for too frequent replacement of their batteries. Especially welcome, therefore, is the news that a new dry battery, developed in America, and now on the market there, gives greatly increased capacity, for considerably less bulk. The new cell is stated to use zinc for its negative electrode, an alkaline electrolyte, and manganese dioxide for the positive electrode. The cells are disc-shaped, with the electrolyte absorbed in a small pad of inactive material, in the centre of a "sandwich," and each cell is held together by two caps which look for all the world like the familiar crown-tops which grace a certain well-known beverage. Of more interest, technically, is the claim that a 67½-volt B battery of these cells is 22½ per cent. smaller than one standard type, and yet gives twice as much capacity. It seems a pity that there does not seem much likelihood of these batteries becoming available in this country, as they should go a long way towards making the performance of really small portable receivers much more acceptable to the public, and thus of boosting the demand for them, to the benefit of the industry as a whole.

A Linear Saw-Tooth Generator Using Only Two Valves

The circuit to be described gives a saw-tooth voltage of excellent linearity, suitable for use as an oscilloscope time-base for a wide variety of purposes. The circuit has the great advantage, not shared by many other arrangements, of being usable at very low or very high frequencies, without difficulty. The largest condenser needed to reach a frequency of 8½ c/sec. is only 0.1 μf., while 70 kc/sec. can be reached without using a condenser smaller than 25 μμf.

INTRODUCTION

The production of saw-tooth voltages for use as oscilloscope time-bases is quite a difficult matter, if all the necessary requirements are to be fulfilled. Indeed, so much thought has been put into this particular problem that whole books have been written on what is really a very restricted topic. As a result, any new circuit that is produced is likely to be useful, for there are very few that approximate the ideal. Some arrangements are excellent at high frequencies, others are very good at low; and yet neither may have acceptable performance outside the range of frequencies for which it is most suited. Some circuits are very simple, using only one valve, such as the transitron, but suffer from the disadvantage that they will not work with all valves of the type for which the circuit values are supposed to have been designed. Sometimes one sees recommended circuits whose performance leaves little or nothing to be desired, but which use far too many valves, or are otherwise so complicated that their sphere of usefulness becomes quite restricted. Some circuits, such as the famous Puckle arrangement, as well as using several valves, have serious operational disadvantages. The Puckle, for instance, while it gives a great enough output voltage to make a time-base amplifier superfluous in many instances, suffers from the very real disability that there is no method of adjusting the amplitude which does not also change the frequency, and destroy the locking, so that any change in amplitude necessitates re-adjustment of the frequency and even of the synchronizing control.

The subject of time-base circuits, as can be judged from the above, is thus quite a challenging one. It is doubtful whether the "perfect" time-base will ever be devised, but it is still possible to devise new arrangements which have certain advantages in some respects over those already in use. We trust, then, that those interested in oscilloscopes and their construction will find the following article of interest.

BASIS OF HARD-VALVE TIME-BASE CIRCUITS

Most hard-valve time-base circuits work on the same basic principle, however different their appearance, namely the "integration" of a square-wave. The transitron, Potter, Puckle, and other circuits all come in this category. Basically, they are made up of two parts, first a square-wave generator, and secondly, an integrating circuit. In some of them, such as the one described in *Radio and Electronics* in April, 1948, and used later in our unit-construction oscilloscope published in November, 1948, to January, 1949, the square-wave generator can be quite easily recognized as such, but in others it is disguised by the fact that the integrator, consisting of a single condenser, is so connected to the generator as to disguise it rather well. In the circuit about to be described, however, the two parts really are quite separate, and it is possible to observe separately the original square-wave, and the saw-tooth that is made from it. In other circuits, the two have no separate existence unless the integrator is first disconnected from the generator, when the square-wave can be obtained.

REQUIREMENTS OF A TIME-BASE

What features are most desirable in a time-base intended for oscilloscope work, and which of them are essential rather than merely desirable? The following list may be taken as a fairly comprehensive guide to the requirements:

(1) Ability to work over a wide frequency range.

(2) Stability and ease of synchronization at all frequencies.

(3) Linearity.

(4) Fast fly-back, preferably a constant fraction of the cycle, irrespective of frequency.

(5) Simplicity, so far as is compatible with performance of the standard needed for the particular job in hand.

(6) Possibility of realization without the use of either very large or very small condensers, either in the frequency-determining portion of the circuit, or in the integrating section.

(7) Ability to cover, if necessary, fairly wide frequency ranges without switching.

(8) Ability to function with a reasonably wide range of H.T. voltage, without loss of other characteristics.

(9) Low H.T. current requirements.

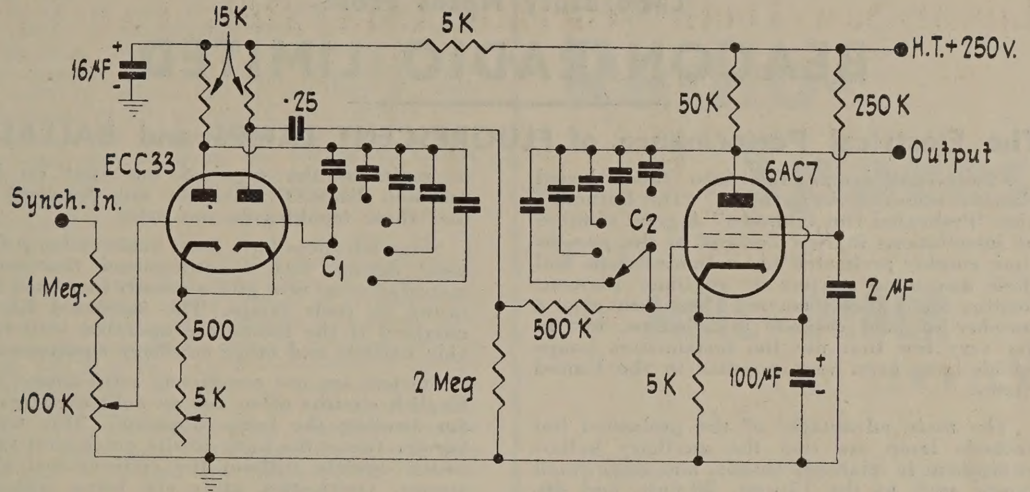
(10) Ability to synchronize well at sub-multiples very much lower in frequency than the synchronizing or "work" frequency.

(11) Possession of a pulse which can be used, if desired in order to suppress the fly-back trace on the C.R.T.

(12) Ability to work without valves having to be specially chosen.

(13) Constancy of output voltage over the frequency range.

All of the time-base circuits that have been recommended from time to time by various authors are able to fulfil some of this list of desirable characteristics, but it is doubtful whether any one of them fulfils the whole thirteen. No claim is made that the circuit which is the subject of this article does this. It does, however, make a rather good attempt at doing so, but before examining how well it succeeds, it may be just as well to describe the circuit.



C1	C2	Frequency
0.1 μf.	0.02 μf.	8.5– 40 c/sec.
0.02 μf.	0.004 μf.	50 – 200 c/sec.
0.004 μf.	0.001 μf.	200 – 950 c/sec.
0.001 μf.	250 μμf.	820 –4500 c/sec.
250 μμf.	100 μμf.	3.6– 17 kc/sec.
50 μμf.	25 μμf.	20 – 70 kc/sec.

THE NEW CIRCUIT

The whole is a combination of two circuits which were used a great deal in radar during the late war. The square-wave generator comprises a double triode in a free-running cathode-coupled multivibrator circuit. This is one of the best types of multivibrator known, for use in cases where the output waveform must be highly unsymmetrical. Any multivibrator intended as the basis of a saw-tooth generator answers to this description, since we always want the forward stroke to be as great, and the flyback as small a fraction of the time of the whole cycle as possible. If the flyback is fast enough, in relation to the forward stroke of the time-base, it will be almost invisible, and it will not be necessary to black it out by applying a waveform to the grid or cathode of the C.R. tube. Unfortunately, a multivibrator which will give a highly asymmetrical waveform is the most difficult kind to make. There are circuits in existence which enable mark-space ratios of 50 or even 100 to one to be obtained, but these are so complicated as to be quite unsuitable for the present purpose. The cathode-coupled circuit, however, lends itself very well to generating the kind of waveform we want. It also has other advantages. Because one of the cross-couplings between the valves consists only in tying their cathodes together, the circuit has two "free" electrodes, which take no essential part in the multivibrator action. These are the grid of V_{1a} and the plate of V_{1b}. In other words, it would be possible to earth the grid of V_{1a} directly, and to omit the plate load resistor of V_{1b} altogether, without affecting the multivibrator action. As a result, these electrodes are available for other functions. The plate of V_{1b} is used as a pick-off electrode, enabling a sort of electron-coupling to be utilized, whereby the attachment of the succeeding circuit to the multivibrator cannot affect it adversely. In circuits like this, in which very rapid voltage jumps are needed, especially if the thing is still to work at high frequencies, one of the worst "gremlins" is stray capacity. The connection of anything at all to an ordinary multivibrator adds stray capacity, and makes it more difficult to secure proper operation at the highest frequencies, so that where electron coupling is used, as here, there is an immediate advantage in this respect. As well as having to take output from the MV, some means must be provided for feeding in the voltage which is to lock the time-base. This is where the "spare" grid of V_{1a} comes in, A 100k. resistor can be inserted between this grid and earth without affecting the multivibrator action at all, and enabling synchronizing voltage to be applied. The circuit is very sensitive to voltages applied in this way, so that only a very small fraction of the Y deflecting voltage need be used. It is therefore possible to use a very large fixed resistor in series with the 100k. synch. control potentiometer, so that the output of the Y amplifier, or that of its first stage (should it possess two) can be connected to the synch. terminal without affecting the amplifier's performance in any way.

THE INTEGRATING CIRCUIT

The integration of the square-wave produced by the multivibrator could be done very simply by connecting a condenser from the plate of V_{1b} to ground, and this method is actually used in some circuits. The main disadvantage of the method, however, is that if the condenser is made large enough to give a really linear saw-tooth, the output voltage becomes very small. Up to a point, this is not a grave disadvantage, but it is desirable to have an output from the saw-tooth generator of at least several volts, so that a high-gain amplifier is not necessary, and so that expansion of the trace can be obtained, simply by increasing the amplifier gain and using the shift control to put the required portion of the trace on the screen of the tube.

An improvement on the simple condenser is the Miller integrator circuit, comprising V_2 and its associated components. This is basically an amplifier stage with its grid-plate capacity artificially enlarged by connecting a condenser between grid and plate. The well-known Miller effect then comes into play, and gives the valve an input capacity approximately equal to $(M + 1)C_{gp}$, where M is the amplification from grid to plate, and C_{gp} is the actual grid-plate capacity. In the circuit used, the valve is a 6AC7, and its plate load resistor is 50k. Under these conditions, the mutual conductance will be

much less than the nominal value, but even so it is likely to be of the order of 2 to 3 ma/v. This would give the circuit an amplification from grid to plate of 100 to 150 times. Thus, with a condenser of 100 $\mu\mu$f. connected between grid and plate, the actual input capacity would be between 0.01 μf. and 0.015 μf., while with a condenser of 0.01 μf. the effective capacity from grid to earth would be between 1 and 1.5 μf. Apart from anything else, therefore, the use of the Miller circuit enables the effect of quite large condensers to be obtained with only very small ones. This is a consideration when space is at a premimum, as is often the case in compact instruments. The main advantage of the Miller integrator, however, is that it enables both excellent linearity and reasonably large output to be obtained. This is simply because in the process of producing the capacity which performs the integration (together with the 500k. resistor between the coupling condenser and the grid of the 6AC7) it also amplifies considerably, thereby almost offsetting the fact that the integration of the square-wave produces a saw-tooth of very much smaller amplitude than the square-wave itself. Another advantage of the Miller integrator is that the output amplitude does not vary very much over the range of the fine frequency control.

The overall circuit has one feature that might be a slight disadvantage in some circumstances. It is that the flyback ratio deteriorates at the high-frequency end of each band. This is because for any one condenser value in the multivibrator circuit, varying the grid resistor of V_{1b} causes the mark-space ratio of the square-wave to change slightly. However, the effect is not serious, and quite good flyback ratios are obtained at all frequencies, even as high as 50 to 75 kc/sec. It is worth noting that the cathode-coupled circuit of V_1 can be made to produce very narrow pulses by making the condenser as small, and the resistor as large as possible, for a given RC product. The RC product will determine the oscillation frequency, but the flyback ratio will be largely deetrmined by the R/C ratio. It may be found that halving the condenser values and doubling the resistors in the grid circuit of V_{1b} will give better flyback times for situations where good flyback is especially important. For all ordinary purposes, though, the values shown will give perfectly acceptable results.

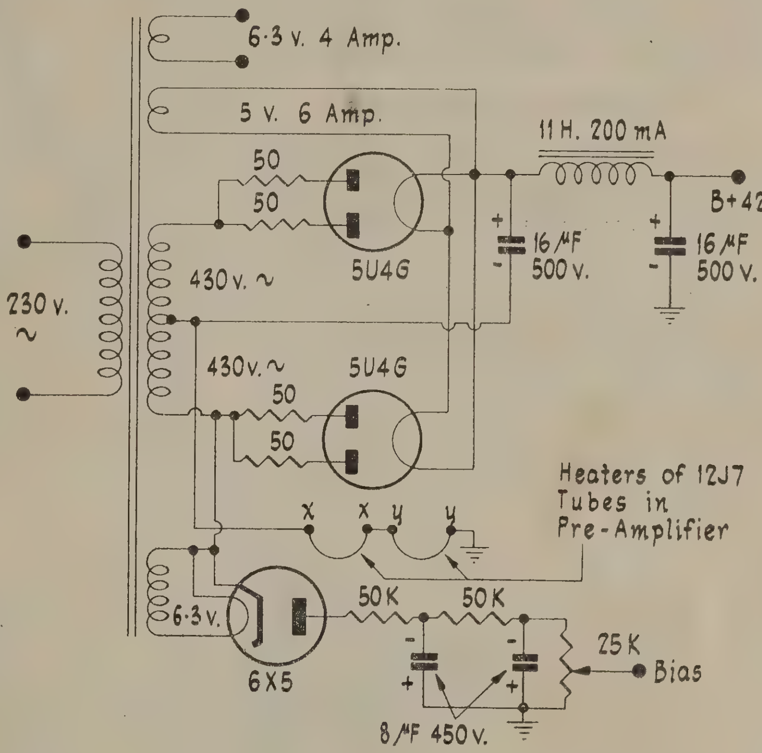
SOME POINTS ABOUT PRACTICAL APPLICATION

It will probably have been noticed that there is a preset rheostat in the cathode circuit of the multivibrator. Its purpose is to enable the best operating conditions to be chosen for the multivibrator. Unless valves are used which agree very accurately with each other in characteristics, a circuit like this would not necessarily be very satisfactory. The pre-set is there in order to ensure that proper operation can be obtained for any valve of the specified type, or even to allow some scope for the substitution of other types which may have the same socket connections. On the low-frequency ranges the cathode resistor could be fixed at 500 ohms, but it is an advantage to have the control there for obtaining the best results on the higher frequencies. If the resistance in the cathode is too high, the circuit will stop operating altogether, and the correct procedure is to set the frequency controls at the highest frequency to be reached by the time-base, and then to adjust the pre-set cathode resistor until oscillation starts. It is then reduced slightly, and left. The performance on all other frequencies will then be satisfactory.

(Concluded on Page 48.)

A Simple Circuit for a High-powered Amplifier—Part II

In last month's issue we described the circuit of the main amplifier, together with suitable pre-amplifying and audio mixing circuits. The continuation, presented below, discusses some of the problems to be encountered in designing a suitable power supply for the amplifier, and describes a circuit that will guarantee the necessary H.T. voltage, with satisfactory regulation.



THE REQUIREMENTS OF THE POWER SUPPLY

Many people seem to regard the power supply portion of an amplifier as a necessary evil, which can be provided with the minimum of effort by slinging together any old transformer, rectifier, and smoothing circuit. Unfortunately, in many instances, such an approach to this important part of the equipment leads to disappointment in the results, and in a good deal of wasted money. The reason is, of course, that the circuits which provide the D.C. power to run the amplifier, are worthy of as much attention in the planning stages as the amplifier circuit itself. This is especially true when we come to deal with amplifiers producing more than a few watts of output. Small amplifiers almost invariably run under Class A or near-Class-A conditions, with the result that there is little or no variation in the current drawn from the power supply as the output is increased from zero to maximum. When this is so, it is obvious that the regulation of the supply is quite unimportant. It is only when larger valves, operating in Class AB, are used, that there is much variation of the drain on the H.T. rectifier, but when such variation occurs, it must be carefully taken into account if the amplifier is to behave as it should.

When we design an amplifier, we start by assuming certain fixed conditions, among which are the voltages that are to be applied to the various electrodes of the valves used. The design proceeds from there, with the tacit assumption that when the amplifier is built and put into operation, it will at all times be provided with these voltages, which will not change. In practice, however, there are very few times when such an assumption is at all justified. One is when we are dealing with valves powered by dry batteries, and the other is when the circuits we are interested in draw only a fraction of the total current delivered by the power supply, so that any variation which occurs is only a small proportion of the maximum current delivered by the supply.

The most difficult power supplies to design are those which are intended for high-powered Class B amplifiers, in which the D.C. input power varies from almost zero at zero output, to something very large at maximum output. Luckily, the present case is not one of the more difficult ones, but the amplifier is sufficiently highly powered to make a properly designed power supply essential. Power transformers and large smoothing chokes are too expensive items to have them found unsatisfactory for the job in hand once they have been purchased!

The requirements of the amplifier may be summarized as follows: With 400 volts needed for the plates of the output valves, and 25 volts subtracted from the actual supply voltage by the device of connecting the heaters of the two pre-amplifier valves in series with the H.T. return, as described in the last instalment, a voltage of 425 is required at the output of the smoothing filter. If a 200 ma. choke is used, it can be expected to have a resistance of, say, 150 ohms, so that there will be somewhere in the region of 30 volts drop in this. The voltage required at the cathode of the rectifier will then be 455. All this is quite straight forward, but at this point the real problems start to crop up. For example, what will be the voltage drop in the rectifier? And will it be necessary to allow for the resistance of the secondary windings of the power transformer? What secondary voltage must be used in order to take care of all these voltage drops, and ensure that the output of the supply

is 425 when the amplifier is drawing its maximum current?

These questions can readily be answered by working through a set design procedure, with the aid of a set of graphs prepared from data measured on the various rectifier types available, and from fundamental theory. It is not our purpose here to weary readers with a detailed account of the procedure, but the results will be found very interesting.

First of all, however, there is the question of the maximum and minimum currents required from the supply, because the former will determine the type of rectifier used, and the latter will determine the regulation of the supply.

CURRENT REQUIREMENTS

The voltage amplifier stages take very little current from the supply, and their drain may be estimated at 10 ma. without much error. The plates of the output stage form the major problem, since they draw 102 ma. at zero signal, which rises to 152 at full output. So far, then, we have a total of 11 ma. at zero signal, rising to 162 ma. at full output. The only other things to be considered are the screens of the output stage, and the VR tubes. The screen current of the 807s varies with signal output, just as does the plate current, the variation being from 6 ma. to 17 ma. The resistance in series with the VR tubes has been chosen so that at no signal, a current of 27 ma. flows through the regulator tubes. The total drain of the screen circuit at zero output is therefore 33 ma. Now as the screen current rises to 17ma. the screen voltage remains constant, owing to the regulating action of the VR tubes. This means that the voltage drop across the 3k. series resistor remains constant, and therefore that the current through it also remains fixed. Because of this, we can deduce that the increase of current taken by the screen is exactly counterbalanced by a decrease of current through the VR tubes. The current drawn from the supply therefore remains constant, regardless of the screen current swing. Thus, if we allow 33 ma. for the screen and VR tube currents together, this is simply a constant current, to be added to those already estimated. The total current drains will therefore be 145 to 195 ma. It looks as though a 200 ma. power transformer will be needed, but if the amplifier is to be used on speech or music only, the higher value of current will be drawn only on those moments when full output is reached, and the average H.T. drain will be somewhere between the two limits. Accordingly, it would be quite permissible to employ a transformer continuously rated at 150 ma., especially if the full wattage rating of the filaments is not used, thus allowing the core and windings a little in hand to handle the slight extra H.T. drain.

CHOICE OF RECTIFIER

The choice of rectifier for any power supply is largely governed by the maximum current required, and by the A.C. input voltage needed. In the present case, it would be very unlikely for an A.C. input voltage of less than 400 to give the required output voltage, even allowing for the fact that with condenser input, the voltage at the cathode of the rectifier *can* be as high as 565 volts. This voltage would only be reached at no load, and would not be approached at loads like those we are considering. A look at the valve handbook shows that the 5U4-G and 5Z3 can have A.C. input voltages as high as 450v. R.M.S. when condenser input is used, and that the maximum output current is 225 ma. It looks as if this type would be ideal, so we try the design procedure using a 5U4 and a transformer of 400v. a side, and see where we get to, assuming that the high-voltage secondary would have a resistance of 75 ohms each side of the centre-tap. The design information tells us that the effective resistance of the rectifier would be 377 ohms at a current of 145 ma., and 322 ohms at a current of 195 ma. For a start, let us look at the performance at maximum current. Further reference to the design charts indicates that with an input condenser of 16 μf., the D.C. output voltage of the rectifier is 66.5 per cent. of the *peak* A.C. input voltage. With 400 volts R.M.S. input, the peak input voltage is 565v. and 66.5 per cent. of this is 375v., so that with the drop in the smoothing choke of approximately 30 volts, the output of the filter would be only 345v., which is a long way short of requirements. How much, then does the transformer voltage need to be increased, to achieve the necessary voltage? Earlier, we found that the voltage required at the output of the rectifier was 455. Our calculation shows that this must be 66.5 per cent. of the required peak input voltage, which becomes $455/0.665 = 700$v. The R.M.S. voltage giving a peak voltage of 700 is 495, so that if we used a 500v.-a-side transformer with a 5U4G, and a 16 μf. input condenser, the output would be correct. Unfortunately, the 5U4G is not allowed a higher input voltage than 450 R.M.S., so that such a solution would be over-running the rectifier. What, then, can be done about it?

It will be remembered that the effective resistance of the rectifier valve at full output is 322 ohms. The voltage dropped by the rectifier must therefore be 63 volts. Presumably if another rectifier was used, which had less internal resistance, some of this voltage drop could be avoided. This in itself would help, but fortunately, halving the effective resistance of the rectifier has another, much more important effect on the output voltage. It allows the D.C. output voltage of the rectifier to be a greater percentage of the peak input voltage, and in this way, considerably more is gained than by the simple decrease in resistance of the rectifier. Suppose, for the sake of argument, that we halve the rectifier resistance by using two rectifiers in parallel. This reduces the rectifier resistance to 161 ohms, but at the same time it allows the D.C. output to become 74 per cent. of the peak input voltage. The required peak input voltage is now $455/0.74 = 615$v., corresponding to an R.M.S. input of 430v. This is rather a surprising result, in that only about 32 volts is realized by the direct effect of halving the rectifier resistance, leaving another 33 volts to be picked up by the indirect effect mentioned above.

In this way, the required design is arrived at, as shown in the circuit diagram.

BIAS SUPPLY

It will be seen that the fixed bias needed by the 807s is provided for by using a separate rectifier and smoothing circuit, together with means for adjusting the bias to exactly the correct value. In adjusting this, it is best to measure the total plate current of the 807s at no signal, and adjust this to 102 ma. by means of the bias potentiometer.

Note that a 5-volt winding rated at 6 amps is needed for the filaments of the 5U4Gs, and also that small resistors of 25 ohms are placed in series with the plates of the tubes, to make sure that one does not take all the current at the expense of the others.

The "R. & E." Synch. Signal Generator—Part II

By W. D. FOSTER

Last month's initial instalment of this series described the basic components of a television synchronizing signal generator, and gave a block diagram of the portion which generates the fundamental frequency of the system, viz., 20,250 c/sec. (which is twice the line frequency of the British standard signal) and which, after frequency division by a factor of two, generates the line blanking and line synchronizing pulses. In this instalment, the theoretical circuit diagram of this section is presented and its action described.

THE MASTER OSCILLATOR

The master oscillator, which produces an almost square waveform, at a frequency or 20,250 c/sec., or twice the frequency of the lines of the TV picture, is a free-running multivibrator, using a pentode and a triode valve in a circuit specially designed so that even at the high frequency concerned, the output wave will have sharp transitions, which can be used for accurate timing operations.

The use of a multivibrator for the master oscillator requires a little explanation, because the standard practice is to use a very stable sinusoidal oscillator, whose output is then "squared" by passing it through a series of clipping stages or limiting amplifiers, to give it the sharp transitions referred to above. In this way the advantage is obtained of a stable oscillator, and of having independent means of shaping its output waveform. It is well known, on the other hand, that the multivibrator, while it has the advantage of producing square-waves directly, is particularly poor in the matter of frequency stability. It might therefore appear that the multivibrator would not be at all suitable, since the line frequency is required to be very stable indeed. Fortunately, however, there is another aspect of the matter which makes the inherent stability of the oscillator finally chosen of not very great concern. It is the fact that the master-oscillator's frequency is to be locked to that of the 50-cycle mains, by comparing the mains frequency with the frame frequency. This, of course, is nominally 50 c/sec., but is actually one four-hundred-and-fifth of twice the line frequency and unless the master oscillator's frequency is exactly correct, the frame frequency will differ somewhat from the nominal value. Accordingly, a discriminator circuit is set up, which compares the mains frequency with the frame frequency, as generated by the master oscillator and the frequency dividers, and provides a control voltage which shifts the master oscillator's frequency in the right direction to correct any error that may be present. Because of this, the stability of the master oscillator is not nearly as important as it would otherwise be. In this respect, the multivibrator actually has an advantage, in that it is a very simple matter to control its frequency. Unlike a sine-wave oscillator, which needs a reactance valve connected across its tuned circuit, a multivibrator can be directly controlled by a direct (D.C.) voltage, without the intermediate aid of a reactance tube. Just how this can be done will be explained in detail in a later instalment. In the meantime, the master oscillator has been drawn without showing the frequency control circuits, which in any event cannot be added until the circuits generating the frame frequency have been completed. The circuit values given for the oscillator will be found to give it almost exactly the correct frequency—closely enough to enable the succeeding circuits to be made to work satisfactorily, and to continue to do so when the frequency control is finally added.

MASTER OSCILLATOR CIRCUIT

In the circuit diagram, the master oscillator comprises V_1 and V_2. The valve numbering in this diagram corresponds exactly with the valve numbers given in the block diagram published last month. V_1 is a 6J6 or ECC91 (which is identical electrically) with its sections connected in parallel, giving a composite triode with a very high mutual conductance of 10.6 ma./volt. The second valve, V_2, is a high-slope pentode, but only the control grid, cathode, and screen-grid are concerned in the multivibrator action. The screen acts as the plate of a triode and is coupled back to the grid of V_1. The plate of V_2 is thus left free, and can be used as a pick-off electrode without affecting the action of the multivibrator in any way. The control-grids of both tubes are returned, through their grid leaks, to H.T. plus, instead of to earth. The purpose of this is to stabilize the frequency, which it does by ensuring that the sudden transitions, during which one tube becomes cut off and the other conducting, take place while the slope of the discharge curve of the grid condenser concerned is still great. Also, in the final frequency-controlled version, the grid leaks will be returned to a point of high positive potential, viz., the plate of a control valve, so that the conditions shown here initially are not very different from those under which it will have to work finally, and a minimum of modification to the circuit will be necessary.

There is no particular reason for the inequality of the grid resistors in the multivibrator. Preliminary calculation showed that grid condensers of 25 $\mu\mu$f., in conjunction with grid leaks of the order of 5 meg. would give approximately the correct frequency, and the first practical trial of these values showed that the frequency was a little on the low side. Accordingly, one of the grid resistors was dropped to 2 meg. so as to adjust the frequency. Doing this also had the effect of slightly unbalancing the circuit so that one half-cycle of the oscillation is about $2\frac{1}{2}$ times as long as the other. However, this is quite unimportant, and does not affect the action of the succeeding circuits at all. The output waveform of the oscillator is illustrated in Fig. 3 (a). In this, and in all the other waveforms in Fig. 3, one vertical edge has been marked with an arrow. The purpose of this is to make it easier to follow the action of the circuit as a whole. In Fig. 3 (a), the negative-going voltage step at the plate of V_2 has been so marked, to indicate that in subsequent operations, timing is arranged to coincide with this point on the original cycle. In other words, it is this voltage jump that triggers the

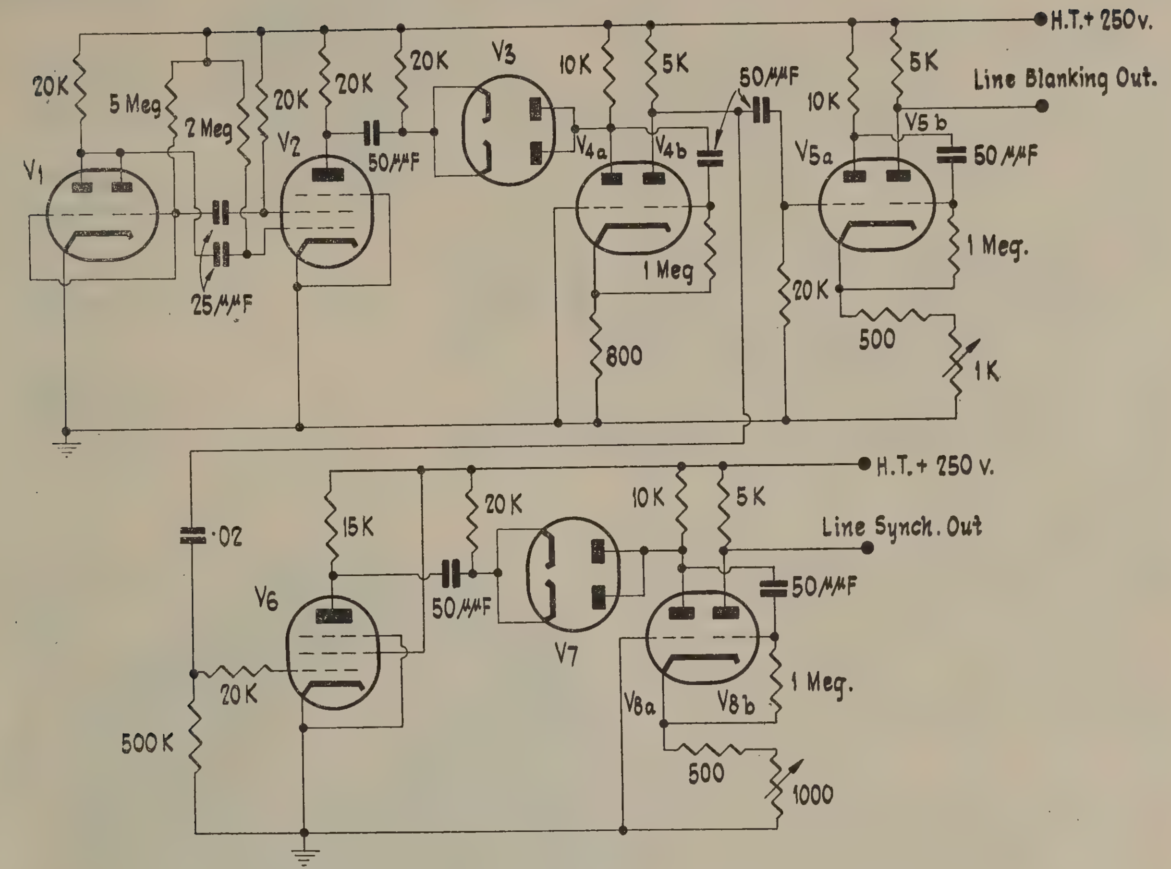


Fig. 2—Circuits referred to by the block diagram of Fig. 1.

next circuit, which comprises V_2 and V_3, and is a frequency divider.

THE FIRST FREQUENCY DIVIDER

From the master oscillator, it is necessary to derive two frequencies, namely the line frequency, and the frame frequency. The line frequency is one half that of the master oscillator, and so can be got from a single stage of frequency division. The frame frequency, on the other hand, requires a chain of dividers giving a total division of 405 times, so that a minimum of three and a maximum of five divider stages will be needed in this part of the circuit. Accordingly, so as to arrive at some of the waveforms finally required with the minimum of work, it was decided to tackle first of all the circuits for generating the necessary pulses of line frequency.

The divider circuit of V_3 and V_4 is one which will be found in many places in this equipment, used for a number of different purposes. Consequently, a fairly detailed description of its method of operation is advisable. The most important part of the arrangement is the circuit of V_{4a} and V_{4b}, which is commonly known as a cathode-coupled flip-flop. For those who may not have met a flip-flop circuit before, it should perhaps be mentioned that it is a variation of the multivibrator. Unlike a multivibrator, however, it is not self-oscillating, and requires a triggering pulse to set off its action. There are a number of kinds of flip-flop circuit, of which the cathode-coupled variety is only one. Fundamentally, there is only one difference between the multivibrator and the flip-flop, namely that the latter has one of its valves biased beyond cut-off. Because of this, it has a stable condition, in which it will remain until some external agency causes the cut-off valve to start conducting. At the moment when this happens, the circuit behaves in every way like an ordinary multivibrator, until the normal action returns the circuit to its original condition, in which it will remain unless it is triggered again. It can therefore be termed a triggered multivibrator, but the name "flip-flop" expresses the action very well, in the shortest possible way.

V_{4a} has its control grid connected directly to earth, and its plate coupled through a CR circuit to the control-grid of V_{4b}. The two cathodes are tied together (in this case by using a valve whose sections have a common cathode) and the grid leak of V_{4b} is returned to cathode, and not to earth. Because of this, V_{4b} is unbiased, and draws as heavy a plate current as the plate and cathode resistors will allow. This current, flowing in the cathode resistor, causes a great enough voltage drop across it to bias V_{4a} beyond cut-off. As a result of this combination of circumstances, V_{4a} remains cut off indefinitely, and V_{4b} passes heavy current indefinitely as long as the conditions are not disturbed. Now if any disturbance takes place which (a) causes V_{4a} to start conducting, or

(b) causes V_{4b} to become cut off, the circuit immediately becomes unstable, in the following way. Let us assume for the moment that a short negative pulse is applied to the grid of V_{4b}; the pulse causes the plate current of V_{4b} to decrease. This reduces the bias on V_{4a}, because a reduction in the V_{4b} plate current also reduces the voltage drop across the cathode resistor. If the amplitude of the triggering pulse was great enough, the bias on V_{4a} is reduced to the point where this valve is able to pass a small amount of plate current. The plate voltage of V_{4a} therefore drops slightly, and this drop is communicated, through the coupling condenser, to the grid of V_{4b}, decreasing its plate current still further. The action is thus regenerative, and goes on until the grid of V_{4b} is driven highly negative—well beyond cut-off—and V_{4a} is conducting heavily. This is just the opposite state of affairs to what obtained before the triggering pulse took place. It is not a stable state, however, because V_{4b} is cut off only because its grid condenser is charged in the right polarity, and to a great enough extent to do so. The charge on the grid condenser cannot remain there indefinitely, but gradually leaks away, until a time arrives when V_{4b} is once more able to conduct. As soon as this happens, it causes an increase in the voltage drop across the cathode resistor, increasing the bias on V_{4a}, causing its plate current to decrease, and its plate voltage to rise. This rise is communicated once more to the grid of V_{4b}, increasing its plate current still further.

This is another regenerative action, and so causes another extremely rapid reversal of the conditions, returning the circuit to the state in which it resided before the triggering pulse, viz. with V_{4a} cut off, and V_{4b} heavily conducting. This time, however, there is nothing in the circuit conditions which can cause a further regenerative reversal to take place, unless another pulse comes along, so the circuit waits in its original condition.

The action described is the fundamental action of the cathode-coupled flip-flop, and it is easy to see now how the name originated. The triggering pulse "flips" the circuit over into the unstable state; then, after an interval determined in length by the circuit values, it automatically "flops" back into its original condition, in which it stays until a further triggering pulse appears.

This same action could just as easily be initiated by placing a positive pulse on the grid of V_{4a}, instead of applying a negative one to the grid of V_{4b}. In either case the action is the same, once it has been initiated.

The above description omits one or two rather important facts about the behaviour of the flip-flop circuit. The first is concerned with the duration of the "unstable" state. This is determined by two things, first the time-constant of the grid circuit of V_{4b}, and secondly, the value of the cathode resistor. For a given value of cathode resistor, the time-duration of the unstable state depends on the time-constant, and will last for aproximately four times the time-constant in seconds or microseconds. This is simply because the larger the condenser, or the grid leak, the longer will be the time taken for the condenser to discharge sufficiently to allow V_{4b} to conduct once more.

It is not at all apparent at first sight why the size of the cathode resistor should alter the time-duration of the unstable period. The effect is due to the fact that varying the cathode resistor alters the voltage to which the grid condenser of V_{4b} becomes charged, and occurs in this way. If the cathode resistor is small, the steady current through V_{4a} during its conducting period has a rather high value, since the self-biasing effect of the cathode resistor is small. But when the cathode resistor

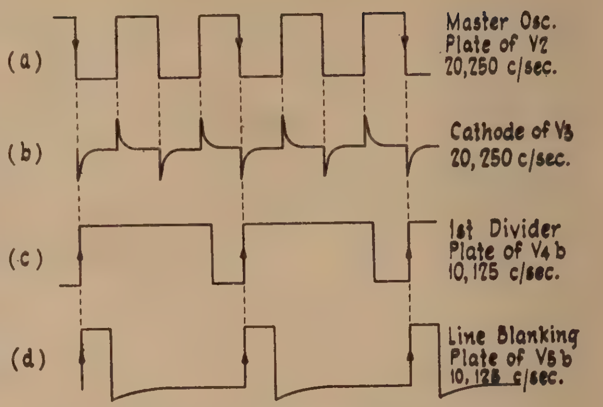


Fig. 3.—Some of the waveforms occurring in the Fig. 2 circuit.

is large, it severely limits the plate current that can flow in V_{a4} while it is conducting, and so decreases the extent of the voltage drop across the V_{4a} plate resistor during the regenerative switch-over. Since it is this voltage drop that determines what voltage the grid condenser of V_{4b} charges, it is found that as the cathode resistor is increased, so the grid condenser is less highly negatively charged. It therefore takes less time to become discharged to the point where V_{4b} is able to conduct again, so that the duration of the unstable state is decreased by increasing the cathode resistor. This fact is made use of when it is desired to exercise control over the duration of the unstable state, and the device is actually used elsewhere in this circuit.

Having seen that it is a simple matter to control the duration of the unstable period of the flip-flop, it is not difficult to see how it can act as a frequency divider. In this particular instance, triggering pulses are fed to the grid of V_{4b} at the rate of one every cycle of the master oscillator. Suppose for the sake of illustration that we label three consecutive triggering pulses *a*, *b*, and *c* respectively. Pulse *a* triggers the flip-flop, which immediately flips over into its unstable state. Now, if we have arranged things so that the unstable state lasts until after pulse *b* has arrived, pulse *b* will not trigger the circuit again, because while it is in its unstable state, a negative pulse applied to the grid of V_{4b} can have no effect on the valve, which is already cut off. In this case, then, pulse *b* is ignored by the circuit, and some time between the occurrence of pulses *b* and *c*, the normal recovery action is completed. Pulse *c* will therefore trigger the circuit again, since it is once more in a position to be triggered. The case just described is clearly one of frequency division by two, for the flip-flop is triggered only by alternate pulses, and so produces one cycle of oscillation for every two cycles of the input waveform.

Should the unstable state have been made long enough for both *b* and *c* to have no effect, with the recovery occurring between pulses *c* and *d*, the flip-flop would produce one cycle of oscillation for every third input pulse, and would therefore give an output frequency of one-third the input frequency. Theoretically, it can be seen that there is no limit to the number of

(Continued on Page 31.)

'Replacement problems don't arise — when service experts

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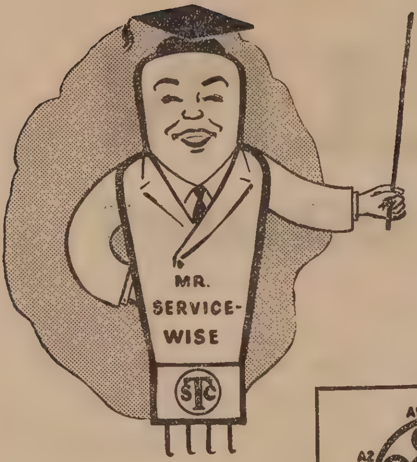
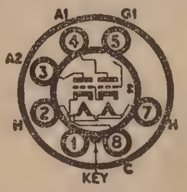
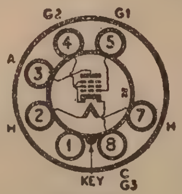


Type 6N6G is a direct coupled power amplifier, the grid bias for which is developed inside the valve.

When replacing by type 6F6G therefore, a cathode bias resistor together with a by-pass condenser must be fitted in series with the cathode lead. No Base changes are necessary and since the sensitivity and loads for the two types are very similar, the power output will be substantially the same.



TYPE 6N6G



TYPE 6F6G

RATED CHARACTERISTICS

	6N6G	6F6G
Heater Voltage	6.3	6.3 volts
Heater Current	0.8	0.7 amp.
Anode Voltage	300	285 volts
Anode Current	43	38 mA.
Bias Resistor	—	400 ohms.
Optimum Load	7,000	7,000 ohms.
Power Output	5.0	4.2 watts

TYPE	CHANGE SOCKET		CHANGE CONNECTIONS		OTHER WORK NECESSARY	PERFORMANCE CHANGE
	FROM	TO	FROM OLD SOCKET	TO NEW SOCKET		
6F6G	INT/OCTAL NO CHANGE		NO CHANGE		Insert Bias Resistor (400 ohms 1 watt) and by-pass condenser (25 mF. 25v.w.) in series with cathode lead (Pin 8 of socket)	NEGLIGIBLE

*BRIMARIZING—a service which first-class dealers can offer those customers whose radio sets have been designed round certain valves which are now in short supply.

BRIMAR
RADIO VALVES

Remember to *BRIMARIZE is to improvise by utilizing an equivalent when a particular valve-type is unavailable.

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Using Standard Time and Frequency Broadcasts

By the Engineering Department, Aerovox Corporation

The standard time and frequency transmissions of the National Bureau of Standard radio stations WWV and WWVH provide an invaluable service to laboratories and individual experimenters throughout the world. Extremely precise audio and radio frequency standards, as well as accurate time intervals and radio frequency propagation warnings, are placed at the disposal of anyone having a receiver capable of tuning to one or more of the transmitting frequencies. The proper use of these facilities can be made to greatly supplement the instrumentation of any laboratory. However, the maximum utilization of this valuable "natural resource" depends upon a knowledge of the broadcasting schedules, transmitting frequencies, and suitable methods of comparison.

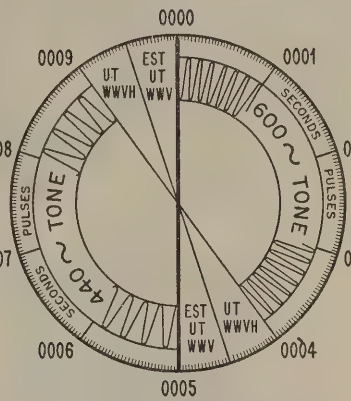
TABLE I

FREQ. (MC.)	POWER (KW.)
WWV	
2.5	0.7
5	8.0
10	9.0
15	9.0
20	8.5 *
25	.1
WWVH	
5	0.4
10	0.4
15	0.4

* *Reduced to 0.1 KW. for first four work days following first Sunday of even months.*

The standard frequency stations WWV and WWVH are operated by the Central Radio Propagation Laboratory of the U.S. National Bureau of Standards. Station WWV is located at Beltsville, Md. (near Washington, D.C.), and WWVH is on the island of Maui, Hawaiian Islands. Both stations broadcast continuously on the carrier frequencies and with the output powers shown in Table I. This diversity of geographical location and transmitting frequencies places the services of these stations on an essentially world-wide coverage basis.

The standard carrier frequency transmissions of WWV and WWVH are modulated with various standard audio tones and time interval signals in order to provide calibration information for a wide variety of instruments. During the first four minutes of each five-minute interval, starting on the hour, the carriers are modulated by accurate sinusoidal tone signals; 600 cycles per second is used during the first four-minute period, followed by 440 cycles during the second period, etc. These two audio frequencies are alternated each five minutes throughout the hour. At the beginning of the fifth minute of each five-minute interval, the tone modulation is interrupted for exactly one minute during which station identification is given in voice from WWV and in International Morse Code from WWVH. Also during this minute, Eastern Standard Time is announced from WWV in voice, and Universal Time is sent in code from both stations.



WWV WWVH TEN MINUTE TRANSMISSION CYCLE

FIG. 1

During the entire transmission, a five-millisecond (0.005 second) pulse signal is superimposed upon the carrier. This pulse consists of five cycles of a one kilocycle sine wave and is heard as a sharp "tick" which accurately marks the passage of each sound. This "seconds pulse" is omitted on the 59th second of each minute to accurately identify one minute intervals. Figure 1 illustrates the transmitting cycle of WWV which is repeated every ten minutes, starting on the hour.

NEW PROPAGATION DISTURBANCE NOTICES

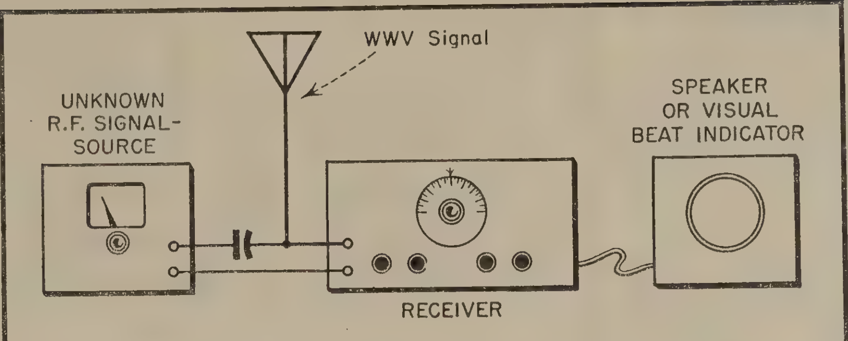
In addition to the standard time and frequency transmissions, WWV also broadcasts radio propagation disturbance warning notices for the benefit of commercial services and amateurs whose communications depend upon conditions in the ionosphere. These announcements are made in code during the 19th and 49th minutes of each hour. As of July 1, 1952, the system was revised to include not only the transmission of a symbol to indicate the present ionspheric conditions affecting communication paths over the North Atlantic, but also a numeral to indicate the condition forecast for the next 12 hours. Thus, the letters "N", "U", or "W" sent five times in code mean that the present radio reception conditions are "normal", "unsettled", or "disturbed", respectively, while a numeral which follows each letter indicates that the forecast for the next 12 hours is for conditions to continue as follows:

Numeral	*Forecast Propagation Condition*
1	Impossible
2	Very Poor
3	Poor
4	Fair to Poor
5	Fair
6	Fair to Good
7	Good
8	Very Good
9	Excellent

According to this system, the characters "W7" transmitted from WWV would be interpreted to mean that the present ionospheric conditions affecting radio propagation were "disturbed" but expected to improve to "good" within the next 12 hours.

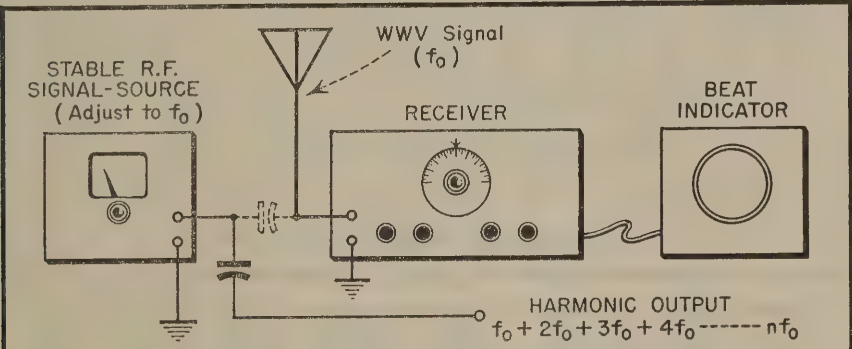
ACCURACY OF TRANSMISSIONS

The accuracies of the audio and radio frequencies and other information broadcast by stations WWV and WWVH are as great as the present state of the engineering art will permit. All frequencies transmitted by both stations are accurate to within 2 parts in one hundred million. A discussion of the means employed to ensure this precision is of general interest and aids in gaining an appreciation of the meticulous care required to maintain the national primary frequency standard.



CALIBRATION OF L.F. SIGNAL SOURCE

FIG. 2



METHOD OF EXTRAPOLATING WWV STANDARDS

FIG. 3

The carrier frequencies at WWV are derived from the average of eight precision quartz crystal oscillators which are operated continuously. These oscillators all operate on 100 kilocycles per second from battery power and are housed in subterranean vaults twenty-five feet below the earth's surface. The temperature and humidity of these vaults are very carefully controlled to ensure maximum frequency stability. The frequencies of the oscillators are compared continually among themselves and are checked against the basic frequency standard—the period of the earth's rotation. The "control standard" oscillator which is chosen to control WWV drives a chain of frequency dividers and multipliers which convert the fundamental 100 kc/sec. frequency to a wide variety of standards ranging from 1 c.p.s. to 30,000 mc/sec. All radio and audio frequencies broadcast are thus derived from one oscillator and are therefore of comparable accuracy. The 60 cycle standard is used to drive a synchronous clock motor which allows the standard to be checked against Naval Observatory time. In this manner, the time signals as broadcast from WWV agree with Naval Observatory time within several hundredths of a second and have a diurnal variation which never exceeds 2 milliseconds.

The frequency standards at WWVH are similar to those used at WWV and are maintained in agreement with WWV signals to within 2 parts in 100 million by comparison. These comparisons are made during the 4 minutes following each hour and half-hour when WWVH is off the air and during 34 minute interruptions which occur at 1900 hours G.M.T.

METHODS OF COMPARISON

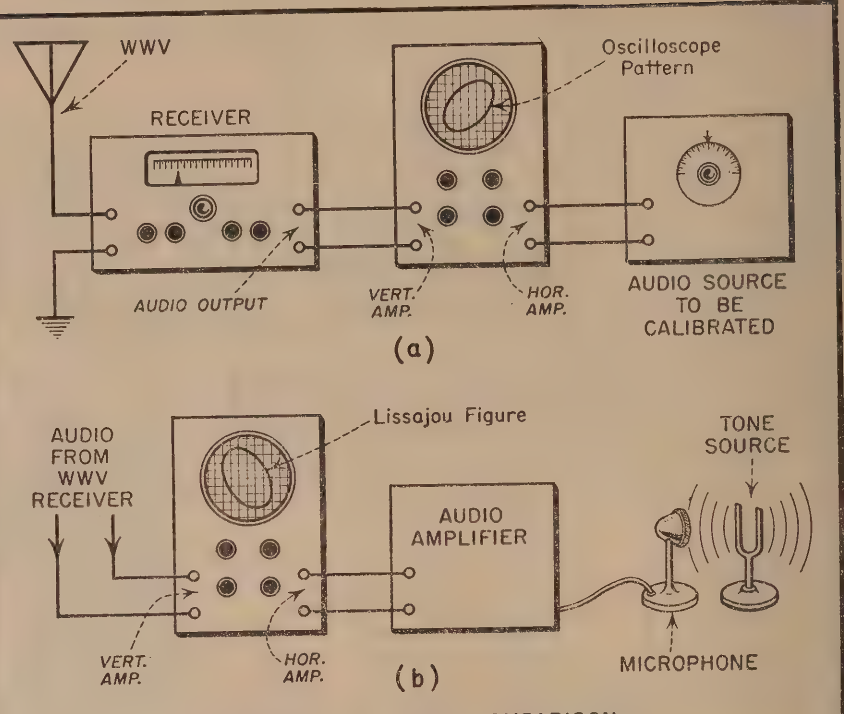
From most points in the continental United States, the standard frequency broadcasts of WWV can be received on a relatively simple receiver. One of the superheterodyne type having good selectivity and automatic volume control is to be preferred, however. These features are usually found in communications- type receivers. Under normal propagation conditions, such receivers are capable of receiving WWV or WWVH transmissions on several of the standard frequencies, thus permitting good flexibility of measurement.

CARRIER FREQUENCY CHECK POINTS

The simplest and most direct way of utilizing standard frequency transmissions is the use of the transmitted signals as check points to calibrate the dial of a receiver. The variety of transmitted frequencies usually ensures that one WWV signal falls within each tuning range of multi-band receivers. The accuracy of the receiver dial calibration may then be checked against the standard frequency carrier and any serious deviation corrected by adjusting either the receiver dial mechanically, or the receiver local oscillator trimmer. In all cases, the receiver should be allowed to reach thermal equalibrium before comparisons are made.

CALIBRATION OF LOW-FREQUENCY R.F. SIGNAL SOURCES

Figure 2 illustrates a method of comparing the frequency of tunable signal sources such as signal generators, grid - dip meters, and amateur V.F.O.s with the WWV standard. The method is also applicable to fixed frequency standard oscillators which operate close to some *sub-multiple* of a WWV carrier frequency. The signal source to be calibrated is loosely coupled by radiation or capacity coupling to the WWV receiver, which is carefully tuned to an appropriate WWV signal. The frequency of the signal source is then varied until a beat note between one of its harmonics and the WWV carrier is heard in the receiver output. When the local signal is adjusted to produce zero beat, its frequency is exactly equal to that of WWV or is an exact sub-multiple



METHODS OF AUDIO COMPARISON

FIG.4

of it. If the device being checked has an approximate calibration, the order of the harmonic is easily identified. Otherwise, the fundamental frequency of the unknown source can be found by determining the frequency difference between two adjacent harmonics on the receiver. Thus, a 1 megacycle signal will produce a beat with the 5 megacycle carrier of WWV and will also be heard at 4 and 6 megacycles on the communication receiver, while a .5 megacycle signal will beat with the 5 megacycle carrier and will also be heard at 4.5 and 5.5 megacycles. This makes it possible to obtain many check points which will be highly accurate as long as the integral multiple is maintained at zero beat with WWV. A visual beat indicator, such as an audio output meter across the receiver output, is usually more accurate than the aural method.

UPWARD EXTENSION OF STANDARD FREQUENCIES

The method previously described allows frequencies lower or equal to the WWV standard to be calibrated. When it is necessary to provide standard checks points at frequencies considerably *higher* than the highest available WWV carrier, the arrangement shown in Fig. 3 is employed. In this method, a tunable R.F. oscillator of suitable frequency stability is zero beat in a receiver with the WWV standard. The harmonics of this oscillator will then appear at precisely integral multiples of the standard frequency to which it is referred. If the auxiliary oscillator has sufficient power output, these harmonics will extend quite high in frequency and may be used as "markers" throughout the V.H.F. and lower U.H.F. regions.

AUDIO FREQUENCY COMPARISONS

Electronic audio equipment, as well as musical instruments capable of sustained tones, may be referred to the 440 and 600 cycle tones broadcast by WWV or WWVH by means of the layouts illustrated in Fig. 4. For audio oscillators and other equipment having an electrical output signal, Fig. 4a is employed. The output of the WWV receiver (tone control and beat frequency oscillator off) is coupled to the amplifier feeding one set of plates of an oscilloscope, while the output of the device being calibrated is coupled to the amplifier feeding the other set of deflection plates. When the frequency of the local source is adjusted to equal the audio tone being transmitted by WWV, a stationary circle or ellipse will appear on the cathode ray tube. Other integral multiples or submultiples may easily be identified by means of the Lissajou figure produced. A description of the use of Lissajou Patterns may be found in any engineering text.

To calibrate the musical pitch produced by non-electronic sources, the equipment shown in Fig. 4b is required. Since the source does not produce an electrical audio output, a microphone and suitable audio amplifier must be used to convert the audio output of the device into an electrical signal for comparison with that received from WWV. As in Fig. 4a, the frequency of the unknown source is identified by the oscilloscope pattern produced.

(Concluded on Page 48.)

SHOES and SHIPS

"The time has come," the Walrus said "To talk of many things. . . . "

By Special Arrangement with the Walrus

Mechanical Features in Radio Sets

The stimulus for this article comes from a half-hour wrestle with a small set over the comparatively simple job of parting the set from its cabinet. It would seem to be a fairly simple job to install a set in such a manner that its removal from its cabinet or carrying case should not be too serious an operation and in this respect present-day manufacturers seem to be making a retrograde step. Time was when all sets responded in the same manner—namely remove the two or four chassis bolts from under the cabinet, remove the knobs, pull out the speaker plug, and presto, the set is yours! Nowadays, however, all sorts of pleasant surprises are in store for the unsuspecting serviceman, and certain portables and radio-gramophones are almost beyond belief in their complexity. This aspect of set design is something which should receive just as much attention as sensitivity, signal-to-noise ratio, power output, and the like.

Manufacturers may argue that accessibility is not so important a feature compared with performance, but they should bear in mind that the radio serviceman who has to cope with this problem is very frequently called upon to recommend a particular make of set to an intending purchaser of a new radio. Needless to say he is not going to recommend a set that will cause him any service difficulties and the word soon gets round amongst the trade as to what set is a bad one from a service angle.

Some sets overcome the accessibility problem by providing a detachable panel underneath the cabinet so exposing the components. This in itself is not a complete answer and cannot take the place of entire removal of the chassis, for it is definitely not easy to trace circuitry where part of the wiring is obscured or where it may duck through the chassis to perhaps an aerial coil, volume control, or similar component placed above chassis.

One make of set seen recently has shown some thought in this direction and the chassis can be removed without even turning the set over—all the screws are able to be got at from the back and the knobs are of the pull-off variety, making the job quite simple. Talking in terms of knobs these push-on types are definitely to be preferred to the grub-screw type. They are easier from the service point of view and don't normally come loose. It It would be interesting to know the number of hours that have been wasted trying to remove grub-screw type knobs where half the top of the grub-screw has broken off! Possibly the worst arrangement of all, however, is where a mixture of both types of knob is used—many a shaft has been almost yanked from its moorings before the offending grub-screw has been located.

Another common failing in radio sets is in the length of speaker lead provided. Unless the speaker is an integral part of the chassis surely it would seem good sense to provide sufficient spare lead to lift the chassis well clear of the cabinet without having to unscrew the speaker. It's a small point that makes service so much easier.

Continuing in critical vein, one could expound for hours on dial movements, Since the dial is one of the things the public does see and is influenced by when purchasing a set, considerable attention is paid to this feature of the modern radio. Unfortunately, a large proportion of this attention goes into the frontal view, and what the serviceman sees behind it in the shape of cords, pulleys, springs, etc., is enough to make a man give up putting water with his whisky. The slide rule type dial in its simple form can be quite effective despite its Heath Robinson appearance, but it is not altogether a type that lends itself to easy mass production. The adjustment and smooth working of such a dial requires careful individual attention in each case to get a minimum of backlash and a maximum of freedom for spin tuning purposes. The cord tension has to be adjusted to a nicety so that when the temperature in the set rises the cord doesn't expand and start to slip. Also, if the cord takes too many turns around the drum before reaching the tension spring the friction is so great that the spring exercises no tensioning control. Another common failing is to place the tuning shaft too close to the drum so that when the cord works up and down the shaft with normal tuning movement it gets so far out of line with the drum that it just slips off, immobilizing the whole movement. Some manufacturers, in order to overcome this trouble, groove the tuning shaft to stop the cord winding up and down, but this nearly always introduces more trouble, either by causing one loop of the cord to lap over the next one, thereby locking the tuning, or otherwise by causing adjacent loops round the shaft to butt so tightly together that it introduces a feeling a inertia or spring in the control that makes tuning on short waves extremely difficult.

Oh well, that gets rid of a series of grizzles, probably there would be a humorous side to it if it wasn't so serious for, in practice, the customer pays for all the foregoing difficulties in the shape of extended service time.

The PHILIPS Experimenter

An advertisement of Philips Electrical Industries of N.Z., Ltd.

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Reprints of these EXPERIMENTER articles, complete with illustrations, will be mailed to any address for one year for a subscription of 5s. Application should be made to Technical Publications Department, Philips Electrical Industries of N.Z., Ltd., P.O. Box 2097, Wellington.

THE RECEIVER AND MODULATOR CIRCUITS

The diagram on the opposite pages gives not only the circuits of the receiver and the modulator, but includes as well all the switching necessary for change-over from phone to C.W., and from transmit to receive. The inclusion of this switching accounts for the somewhat formidable appearance, and at the same time it cannot be denied that there is a good deal of wiring to be done. It is perfectly straight-forward, however, and in operation in the field will repay many times over the effort put into its construction. Lest anyone should mutter "Too complicated," or other criticisms, we would point out that the set-up as drawn was designed with an eye to the greatest possible operating convenience, rather than for beautiful simplicity. At the same time, a closer look at the circuit will show that there is no needless complication.

The receiver proper has been designed with an eye to good performance, because the whole rig is essentially one which would be ideal for emergency use as well as for portable or mobile work. A Philips EF92 miniature variable-mu pentode is used as a tuned R.F. amplifier, followed by a Philips ECH41 as oscillator-mixer, a further EF92 as I.F. amplifier, and a Philips EB91 as second detector and A.V.C. rectifier. A further EF92 is used as a B.F.O., triode-connected. The remaining two valves make up the audio circuits for both receiver and transmitter. A Philips ECC91 is used in the following way. One section is used solely as a microphone pre-amplifier tube. The mike is permanently connected to its grid, and its output is switched to the grid of the second half in the "transmit" position of the switch. This second half is permanently coupled to the grid of the modulator, a Philips EL41, and a further section of the Transmit/Receive switch connects a pair of headphones across the EL41 grid leak in the "Receive" position. The EL41, of course, has its plate and screen voltages removed in the "Receive" position so that it will draw no current.

At one stage it was thought possible to obtain bandspread on both 80 and 40 metres by using only one set of coils, but further investigation showed that this would not be worth while, as it would result in a very unfavourable L/C ratio, and therefore in reduced performance, on the 40-metre band. Accordingly, two sets of coils are used, but the amount of coil winding is somewhat reduced by using a common primary winding in all three cases, with the secondary for each band on opposite sides. In spite of the added complication, it was thought worth while to incorporate full bandspread on both bands, and a suitable combination of series and parallel bandspreading was worked out to enable each band to occupy the whole 180° of the dial. Not the least important point about the bandspreading is that it enables a simple reduction drive to be used on the main tuning shaft, thereby saving valuable space.

On the 80-metre band, parallel bandspreading is used, by choosing gang capacities which give coverage of the band with not too small a shunt capacity. This means that a fair amount of fixed capacity has to be used to bring up the minimum, so that there is any amount of leeway for strays. Since the coils are hand-made, their inductance can be trimmed so that the bandspread is just right, without any difficulty at all. On 40 metres, adjustable series condensers are placed in circuit with the main tuning condensers, since the percentage frequency change on this band is much less than on 80. It will be noted that the circuit is such that three Philips trimmers are called for in each tuned circuit, but the advantage is obtained that the alignment on each band is independent of the other.

No attempt has been made at three-point tracking, since experience has shown that on bands as narrow as these, it is quite unnecessary, and its omission does not result in any noticeable deterioration in performance.

The I.F. is the good old standby of 455 kc/sec., using Philips midget Ferroxcube transformers, and a single winding from a disused 455 I.F. transformer is used as the tuned circuit for the B.F.O.

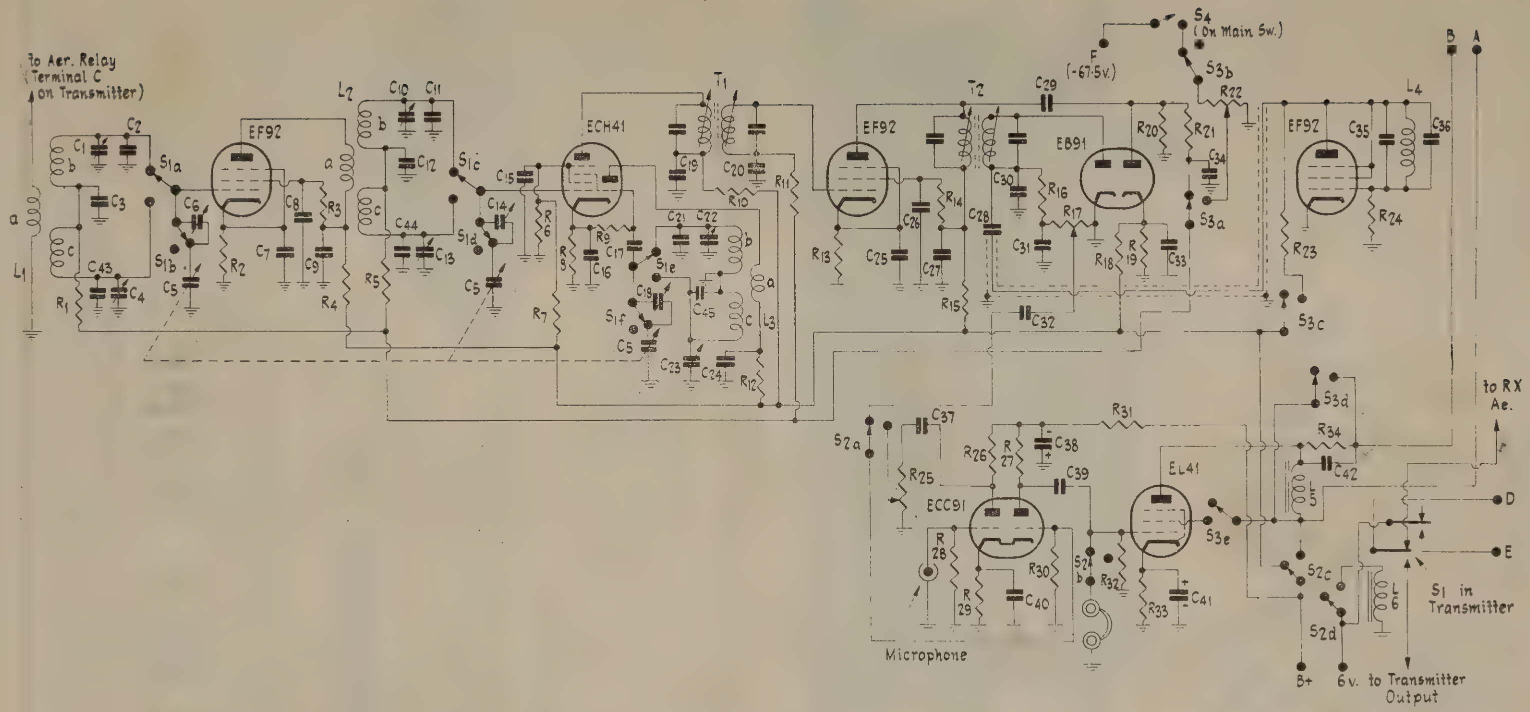
SWITCHING IN DETAIL

A good many of the features incorporated in the design have not yet been mentioned, and it will save space if we go through the switching in detail. This will reveal all the points so far not described.

S_1, of course, is the band-change switch, and needs a total of six poles—two for each circuit. The use of common primaries avoids the need for a further three poles! S_2 is a two-position four-pole switch for Transmit/Receive. Section (a) switches the input of the second audio stage from the output of the detector to the output of the microphone pre-amplifier. Section (b) connects the headphones to the output of the second audio stage on "Receive,' and disconnects it for "Transmit." Section (c) applies H.T. to the screen and plate of the modulator on "Transmit" and to the receive tubes on "Receive," and section (d) completes the circuit of the relay in the transmitter. The contacts of the relay change over the aerial from the transmitter to the receiver, and apply heater voltage to the QQE04/15 on "Transmit."

S_3 is the switch for changing over from Phone to C.W. S_{3a} switches the bias line for the R.F. tubes to A.V.G. in the phone position, and to a manual gain control for C.W. S_{3b} removes the battery from across the manual gain control in the phone position; S_{3c} turns on the B.F.O. for the C.W. position, and S_{3d} short-circuits

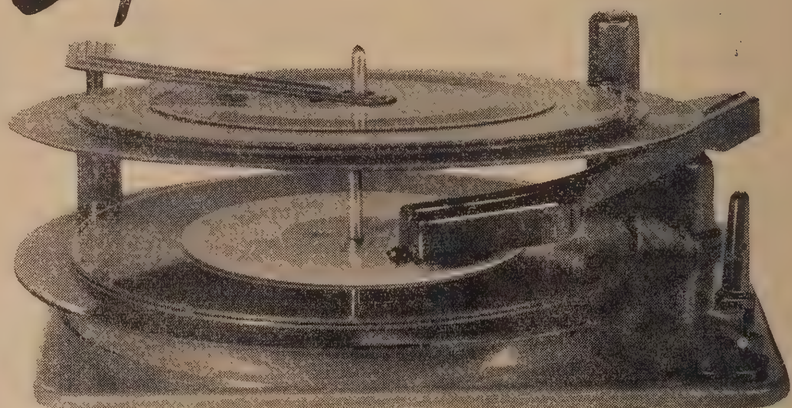
(Concluded on Page 48.)



COMPONENT LIST

R_1, R_5, R_{11}, R_{26}, R_{27}, 100k.
R_2, R_{13}, 250 ohms.
R_3, R_{14}, 25k.
R_4, R_{10}, R_{15}, 2k.
R_6, R_9, R_{16}, R_{24}, 50k.
R_7, R_{12}, 33k.
R_8, 200 ohms.
R_{17}, R_{22}, R_{25}, 500k. pot.
R_{18}, 280k.
R_{19}, 5k.
R_{20}, R_{21}, R_{28}, R_{30}, 1 meg.
R_{29}, 1500 ohms.
R_{31}, 20k.
R_{32}, 500k.
R_{33}, 150 ohms.
R_{23}, R_{34}, see text.
L_1, aerial coil.
L_2, R.F. coil.
L_3, oscillator coil.
L_4, B.F.O. coil.
L_5, modulation choke, 80 ma.
L_6, relay coil (in tx.)
C_1, C_4, C_6, C_{10}, C_{13}, C_{14}, C_{18}, C_{22}, C_{23}, 3–30 $\mu\mu$f. Philips trimmers.
C_2, C_{11}, C_{21}, C_{43}, C_{44}, C_{45}, 25 $\mu\mu$f.
C_3, C_{12}, C_{20}, C_{32}, C_{37}, C_{39}, 0.01 μf.
C_7, C_8, C_9, C_{15}, C_{16}, C_{19}, C_{24}, C_{25}, C_{26}, C_{27}, C_{33}, 0.05 μf.
C_5, 3-gang condenser, see text.
C_{17}, C_{29}, 50 $\mu\mu$f.
C_{28}, see text.
C_{30}, C_{31}, C_{36}, 100 $\mu\mu$f.
C_{34}, 0.02 μf.
C_{35}, 25 $\mu\mu$f. midget variable.
C_{38}, 16 μf. 350v. electro.
C_{40}, C_{41}, 25 μf. 25v. electro.
C_{42}, 2 μf.
T_1, T_2, Philips Ferroxcube midget I.F. transformers.

"Absolutely Lifelike"



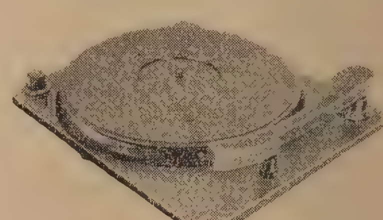
How many similar expressions could be used to describe the merits of the new Monarch auto-changer? Given the opportunity our advertising men could, doubtless equal Roget. But our finest phrases could not entrance you as would your favourite symphony played as you have never before heard it. You can see this remarkable three-speed auto-changer at all good-class radio showrooms—a demonstration will convince you that our heading is fully justified.

noteworthy features—

Automatically selects and plays 12 in., 10 in., and 7 in. records. Capacity: 10 records, inter-mixed, in any order. New reversible dual stylus crystal pick-up has extended frequency range. New record-change mechanism virtually eliminates pause between records.

THE G.U.4a

A beautifully styled gramophone. Complete with ingenious automatic stop and lightweight, high-fidelity turn-over type crystal pick-up fitted with two permanent sapphire styli.



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The "RADIO and ELECTRONICS" Abstract Service

AERIALS AND TRANSMISSION LINES

The noise reducing properties of the loop aerial are not well known, but this is the case for the low frequencies, the loop serving to reduce interference from electrical machinery; disturbance from these latter show a predominance of the electrical component, so the loop aerial is able to discriminate against noise better than the capacitive aerial. Suggestions given for winding the loop, and methods of calculating the dimensions.
—*Wireless World* (Eng.), November, 1952, p. 469.

Ultra-high-frequency antennae: in America designers are faced with an expansion to the 470-890 mc/sec. bands, and here, due to much attenuation in travel, the aerial becomes most important. The article commences with a study of the half-wave dipole, which is the standard against which others are compared. The parameters of fan aerials, rhombic, stacked V, and others are discussed.
—*Radio and Television News* (U.S.A.), December, 1952, p. 38.

CIRCUITS AND CIRCUIT ELEMENTS

Power supply filters—fundamental facts for the beginner: a comparison of choke and condenser inputs, and the theory of filtering.
—*QST* (U.S.A.), December, 1952, p. 43.

The construction given of a stable-output oscillator which is immune to voltage and heater changes; a crystal is employed which is stabilized by the circuit which includes a control section. The oscillator is said to be simple and easy to install, and has good long and short term stability.
—*Electronics* (U.S.A.), October, 1952, p. 154.

Electronic switching: the article relates to applications of the cold cathode gas discharge triode. Circuits given of a simple coincidence gate; coincidence gate and store; and use in digital chain counters. The coincidence gate is triggered only when the anode and trigger pulses coincide. In low frequency switching the cold cathode triode can be used as a relaxation oscillator, or as multivibrators. The article refers also to polyelectrode tubes wherein the ionization of one anode-cathode gap triggers the other gaps.
—*Wireless World* (Eng.), November, 1952, p. 465.

AUDIO EQUIPMENT AND DESIGN

An article on the uses of ultra-sonic sound: it is now possible to generate "sound" waves of the order of 500 million cycles per second, and such may be used for mixing liquids, destruction of germs, killing of small pests, precipitation of smoke etc. Magnetrostriction is used for frequencies to 100 kc/sec. and crystals for still higher frequencies. The useful properties of the sound waves are demonstrated.
—*Radio and Hobbies* (Aust.), January, 1953, p. 12.

A pre-amplifier for magnetic pick-ups: details given of an easy-to-build unit using a single tube and incorporating a selenium rectifier power supply. Three methods are mentioned of obtaining bass boost, and the circuit given combines the benefits of negative feedback with the advantage of a by-passed or grounded cathode.
—*Radio and Television News* (U.S.A.), December, 1952, p. 34.

The device described provides a simple means for communicating between rooms or sections of a dwelling—with the feature that the A.C. power lines are utilized as the connecting link between the transmitter and the receiver. Both units are normally receivers but are converted into transmitters when a spring-loaded switch is actuated.
—*Ibid*, p. 45.

The article traces the development of the loudspeaker: it was decided to produce a cone that was as rigid as possible in order to study its harmonic production; a further study was made of "driving force distortion" and "restoring force distortion" which govern the movement of the cone. These tests resulted in the production of a metal cone for the loudspeaker in the instrument produced by General Electric.
—*Wireless World* (Eng.), November, 1952, p 440.

ELECTRONIC DEVICES

A novel capacitance relay: these devices are used in industry to handle counting and sorting operations, but the author first used his relay to train the family cat, and a feeler antenna placed under a chair, warned of the cat's approach. The device works on any change in the capacitance relationships between the "feeler" and the surroundings. The apparatus draws only two watts, and therefore can be left in operation for long periods.
—*Radio and Television News* (U.S.A.), December, 1952, p. 50.

Electron beam sterilizes food and drugs: the high energy electron beam affects living organisms adversely due to their complex chemical structures without too much effect on the medium in which they live. The high velocity beam is provided by the Van de Graff accelerator which has a scanned beam output. Compact units are being designed for the purpose and show promising results as the product can be sterilized in the final sealed container so avoiding the risk of recontamination, and it seems that complete sterility can be assured for each product.
—*Electronics* (U.S.A.), November, 1952, p. 98.

The article deals with electrical apparatus for medical use, with emphasis on unsafe, ineffectual, and inconvenient apparatus. The time is not long past when doctors in the U.S.A. were attempting to treat their patients with long blue electric sparks from gigantic frictional machines. Others have experimented with galvanic current therapy, vibrators, exercise apparatus, heat therapy, and ultra-violet radiation, etc. The Council on Physical Therapy has done much to sort out the good from the bad, and some of its findings are given.
—*Electrical Engineering* (U.S.A.), November, 1952, p. 993.

INSTRUMENTS AND TEST GEAR

A duo-diode modulation monitor is described. The article is designed as a low cost unit which will indicate 100 per cent. negative peak modulation on plate modulated transmitters without a high voltage diode. Neon indicators are used as indicators, with a meter for reading modulator plate current.
—*Radio and Television News* (U.S.A.), December, 1952, p. 55.

The author has designed an instrument he calls the "Hetromon" which implies versatility in testing. It comprises a 100-1,000 kc/sec. crystal secondary standard; a heterodyne oscillator for beating against the crystal; a fixed audio frequency oscillator; modulation percentage indicator and phone monitor.
—*QST* (U.S.A.), December, 1952, p. 32.

MATHEMATICS

A universal skin-effect chart for conducting materials is supplied. This chart gives skin depth, napier depth, and depth of penetration of current in various metals up to the highest frequencies. One use is in estimating transmission between underwater loop antennas, such as submarine to submarine or submarine to ship radio communication through salt water.
—*Electronics* (U.S.A.), November, 1952, p. 152.

An R.F. coupling nomograph. This gives coefficient of inductive coupling of an R.F. transformer directly from Q-meter measurements, and the procedure permits correcting for effects of distributed capacitance.
—*Ibid*, October, 1952, p. 166.

MATERIALS, VALVES, AND SUBSIDIARY TECHNIQUES

Many engineers have the impression that transistors are easy to make, but it is a complex electrical system that is far from being fully understood. The article deals mainly with frequency response, and it has been found that with proper control of germanium resistivity and spacing between the emitter and collector transistors have been made to oscillate as high as 302 mc/sec. This had not earlier been considered possible and opens the field for high-frequency transistor applications.
—*Electronics* (U.S.A.), November, 1952, p. 116.

It is now possible to meet many requirements for magnetic cores by the use of metallic powders which are insulated and bonded with ceramic or resin coatings. The article deals with the various phases of production and with a comparison of the magnetic materials including ferrites, or mixed iron oxides.
—*G.E.C. Journal* (Eng.), July, 1952, p. 152.

The conventional resnatron is essentially a two cavity device operated so that the electrons are density modulated or bunched and then highly accelerated into the anode gap. In the case of the reflex resnatron, the anode is operated at a negative potential with respect to the accelerator grid so that the beam terminates at the accelerator and is bent back through the ouput cavity. Wideband modulation is accomplished with low modulating power by swinging the repeller voltage.
—*Electronics* (U.S.A.), September, 1952, p. 116.

PROPAGATION AND MODULATION

A discussion on the propagation of waves in the 470 and 890 mc/sec. region, showing that techniques for U.H.F. broadcasting will differ materially from those employed for the lower frequencies. An improvement can be effected by "Beam Tilting," or raising the beam from the horizontal, thereby aiming the maximum of the vertical radiation pattern within the range served by the transmitter, and thereby limiting the beam to a useful range. The question of beam shaping for effective propagation is also discussed.
—*Electronics* (U.S.A.), November, 1952, p. 102.

How to transmit information efficiently is the big problem in communication engineering these days, and it is necessary to envisage reshaping or encoding the intelligence to suit the peculiarities of the channel. The studies move towards economy of television bandwidth, and colour television where bandwidth is even more important. The reduction of noise is of course important, and one way is to introduce redundance or the

(Continued on Page 47.)

DON'T

Please don't confuse the name BRIMAR with other valves of similar trade names . . . there is only *one* BRIMAR known and trusted throughout the world.

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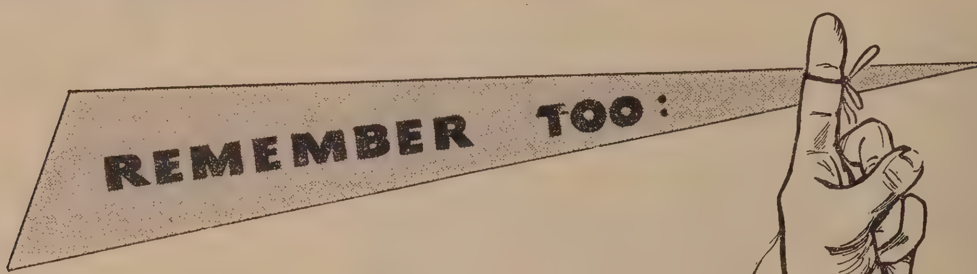

- BRIMAR'S reputation for dependability is unassailable and proven. The world's gigantic radio installations, B.B.C., Eiffel Tower, the Queen Mary's and Queen Elizabeth's, and the Comet's radio *all* rely on BRIMAR *exclusively*.
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An announcement by

STANDARD TELEPHONES AND CABLES PTY. LTD., Box 983, Wellington.

TUBE DATA: DC80 Directly-Heated U.H.F. Triode

The DC80 is a directly-heated triode intended for transmitting and receiving purposes at ultra high frequencies. It can, for instance, be used as an oscillator, amplifier, super-regenerative detector or mixer in walkie-talkie equipment, balloon sondes, Citizens or Business radio, etc. When the tube is used as an oscillator the obtainable output at 300 mc/sec. (λ = 1 m.) is about 1 watt and at 500 mc/sec. (λ = 60 cm.) about 0.4 watt, while the frequency limit is about 750 mc/sec. (λ = 40 cm.).

The filament voltage of the DC 80 is 1.25 volts at a current of 20 mA. Being a directly-heated tube its mutual conductance has a high value (3.5 mA/V at an anode current of 20 mA); the amplification factor amounts to 14.

In order to make a tube of normal construction suitable for use in the decimetric wave range a number of special measures have been taken. One extremity of the filament is connected to two pins. When the tube is used as amplifier these two pins can be connected in parellel in order to reduce the series resistance and the self-inductance.

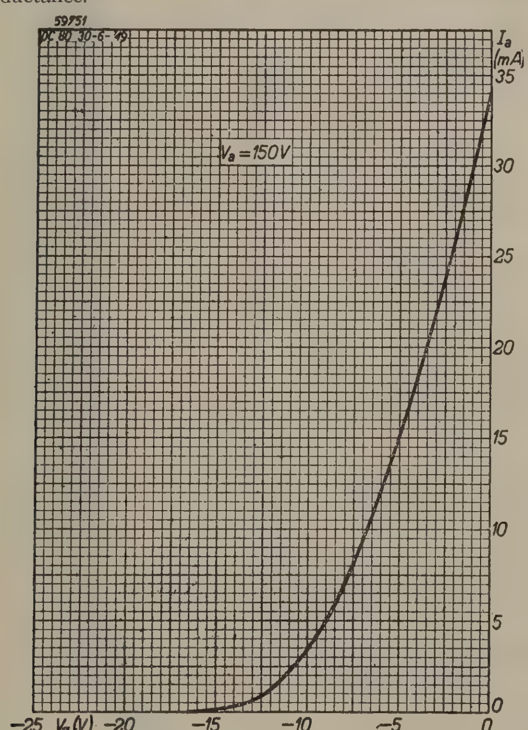


Plate current against grid voltage for the DC80 at a plate voltage of 150.

TECHNICAL DATA

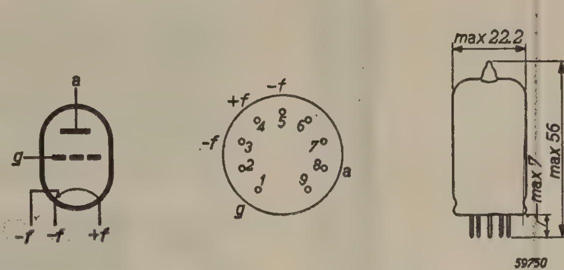
Filament Data

Heating: Direct by battery.

Filament voltage	V_f	=	1.25 V
Filament Current	I_f	=	0.2 A

Capacitances (measured with the tube in the cold state)

Input capacitance	C_g	=	1.25 pF
Output capacitance	C_a	=	0.75 pF
Capacitance between anode and grid	C_{ag}	=	1.5 pF



Socket connections and physical dimensions of the DC80.

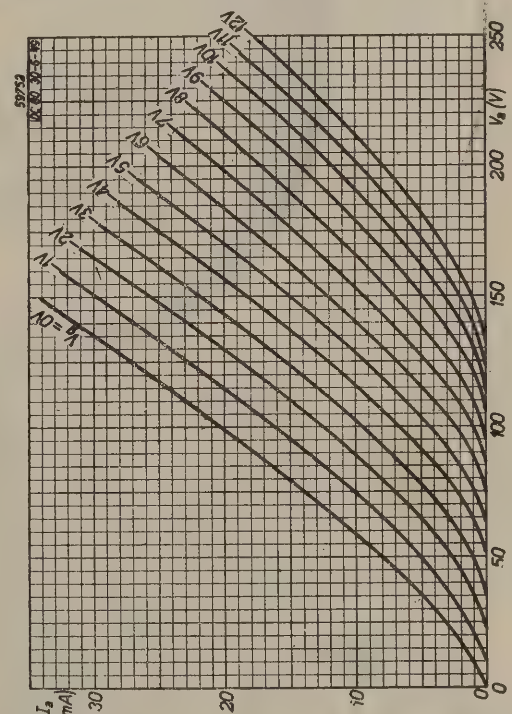


Plate characteristics of the DC80, with grid voltage as the parameter.

Typical Characteristics

Anode voltage	V_a	=	150 V
Grid voltage	V_g	=	—3.5 V
Anode current	I_a	=	20 mA
Mutual conductance	S	=	3.5 mA/V
Amplification factor	μ	=	14

Operating Characteristics as an Oscillator

Anode voltage	V_a	=	150 V
Cathode current	I_k	=	20 mA
Grid current	I_g	=	1.5 mA
Frequency	f	=	470 mc/s.
Output power	W_o	=	0.45 W

(Concluded on Page 47.)

Synch. Signal Generator

(Continued from Page 14.)

pulses that can be "skipped" in this way, and thus no limit to the division ratio, but in practice the number that the circuit can divide by is limited by the accuracy with which the duration of the unstable state can be established and held constant. But that is another story.

TRIGGERING THE FREQUENCY DIVIDER CIRCUIT

So far, a suitable triggering voltage has been assumed, with no mention of how it is obtained, or of what sort of triggering waveform is suitable for the job in hand. One might expect that since the flip-flop is unaffected by what happens after triggering has taken place, and before it has returned to its stable state, the exact triggering waveform would not be important. Within limits, this statement is a true one, but the best form for the triggering voltage is that of a very short pulse, of only a few microseconds duration, having a very sharply rising leading edge.

The short duration of the triggering pulse ensures that it will not interfere in any way with the flip-flop action, while the sharp rise of the leading edge ensures that the timing of the start of the flip-flop action is very exact. It is quite easy to make a pulse or a square-wave with a transition that is only a small fraction of a microsecond. When such a pulse is used, the operation of the flip-flop is timed to within a fraction of this minute time; in the present case, the necessity of accurate timing is obvious, for the time taken up by one line of the picture is only of the order of 100 μsec., so that if the timing of the synch. pulses was not constant to within a fraction of a microsecond, the random differences in length of the successive lines of the picture could result in serious lack of definition. For example, suppose that the duration of the lines varied because of non-positive triggering somewhere in the system, to an extent of plus and minus $\frac{1}{2}$ μsec. Suppose, moreover, that a picture 10 in. was to be produced. Then, ten inches on the kinescope face would represent 100 μsec., and the total variation of 1 μsec. would represent a length difference of a tenth of an inch. This would mean a very noticeably jagged edge to the picture and worse than this, a picture element that was supposed to be directly under another one could be displaced sideways from it by one-tenth of an inch. The picture would actually be quite hopeless. Any such "jitter" in the timing of the synch. pulses must be kept down to unbelievably small proportions, and this is why considerable pains are taken to use only triggering pulses with very sharp leading edges. The sharper this edge, the smaller the possible time jitter of the device that is triggered. It should be remembered, moreover, that in the whole chain of circuitry, where the multivibrator master oscillator is followed by a frequency divider, and then by a pulse generator, jitter may be introduced by each of these component circuits, and will be additive.

The above remarks are not to be taken as an indication that the necessary precision is difficult to achieve, but rather as showing the almost unbelievable accuracy with which timing operations can easily be carried out electronically.

It was mentioned earlier that the flip-flop could be triggered by either positive or negative-going pulses, according to requirements. The master oscillator circuit is such that when the waveform at the plate of V_2 is examined, it is found that the negative-going jump is much faster than the positive-going one. The negative-going one is therefore chosen as the one from which the triggering pulse is to be made, and because of the way in which the pulse is obtained, it has the same polarity as the negative jump in the waveform at the plate of V_2. The circuit which does the job is a very simple one. It consists of the 50 $\mu\mu$f. coupling condenser and the 20k. resistor connected to the H.T. line. These form what is known as a short time-constant circuit. Short, that is, with respect to the duration of one cycle of the input wave. One cycle, at a frequency of 20,250 c/sec., lasts for approximately 50 μsec., and the time-constant of the coupling circuit referred to is only 1 μsec. This simple circuit is also known as a differentiating circuit, because it approximately performs the mathematical operation of differentiation, on the input wave. If it was dealing with a perfectly square wave, in which the transitions took place instantaneously (i.e., in no time at all) the output would be a series of alternately positive and negative pulses of zero time duration, and infinite amplitude! Luckily, however, neither of these theoretical conditions holds true, so that in practice, the waveform to be found at the cathode of V_3 (i.e., the output of the differentiating circuit) is a series of alternately positive and negative pulses all right, but certainly not of zero duration or infinite height. The actual result is well illustrated in Fig. 3 (b). These pulses, it will be noticed, correspond exactly in time with the jumps in the square-wave which is fed to the short

(Concluded on Page 48.)

Missing and Stolen Radios

Criminal Investigation Branch, Auckland

Mullard battery, 230-volt A.C./D.C. portable, model 681, serial No. 26088. Leatherette case with identical plastic grilles back and front.

Arnrite 5-valve battery portable, serial No. 1031. White plastic case 12 in. x 8 in. x 8 in., red tuning and dial knobs, clear plastic carrying handle.

Pacemaker portable, serial No. 97931.

Avalon, 9 in. x 5 in. plastic purple brown escutcheon, silver grey crackle finish on two sides and back. Current lead covered with red insulation entering through back of set. Aerial inlet on right-hand side. Two brown (tuning and volume) knobs, dial 7 in. x 2 in.

Rola mantel model, white bakelite case 14 in. x 7 in. x 7 in. approx.

Police Station, Newmarket

Philco 7-valve mantel model, No. 27756. Dual-wave. Walnut veneer cabinet. "R Kahi" scratched above dial.

Police Station, Mt. Maunganui

Cromwell car radio, serial No. 7150A and 9299A.

Criminal Investigation Branch, Christchurch

National Pacific mantel model, 6-valve, dual-wave. Medium dark stained cabinet, letters "H.C." in capital letters scratched in several places.

Rola personal portable, serial No. 145198; brown case 9 in. x 6 in. x 4½ in.

Pilot dual-wave, 20 in. x 10 in. x 10 in., brown stained cabinet.

Ultimate portable radio, serial No. 126934, Gypsy Model A.C. and D.C. Wooden cabinet, grey crackle lacquer finish, 11 in. x 13 in. x 5½ in. White plastic carrying handle, circular dial, Rola speaker in centre. White plastic dial surround and red pilot light above dial. Three control knobs. "Ultimate" in white plastic on bottom right corner. Back held on by two milled nuts.

Police Station, Temuka

Ariel portable, battery/electric, maroon colour, serial No. 19212G. Size 10 in. x 4¼ in. x 7 in.

Police Station, Featherston

H.M.V. portable "Oxford," Model 525P, serial No. 6536. Battery and electric, complete with batteries. Wine coloured plastic case.

Criminal Investigation Branch, Palmerston North

Pacemaker portable, serial No. 98571, maroon case.

RADIOS RECOVERED

Regent portable Model 4P8, serial No. 9904.

Motorola car radio, serial No. 7077, together with speaker.

Motorola car radio, serial No. 3133 over 4.

Television News

Television Receiving Licences—Great Britain

The number of television licences issued in Great Britain up to the end of July totalled 1,564,254.

Television Set Sales—Canada

The total number of television sets sold in Canada for the month of September, 1952, was 19,241 sets, with a retail value of 8,629,781 dollars.

Sales for the nine months of 1952 totalled 70,209 valued at 32,016,790 dollars.

Cumulative sales of Canadian manufactured television sets up to the end of September totalled 148,647 valued at 69,530,815 dollars.

Lighter, Larger, and Stronger Glass Picture Tubes—U.S.A.

Lighter, larger, and stronger glass picture tubes are now possible as a result of a new banding process developed by the Kimble Glass Co. which virtually makes the tubes implosion proof.

A heated metal band is applied to the face plate where it joins the bulb, resulting in a reduction of the weight of the tube by permitting a thinner glass structure and opens possibilities for pictures of still larger sizes.

Samples of these so-called "K Band" tubes are now being distributed to the industry.

Kimble expect to produce banded tubes in the sizes of 21, 24, and 27 inches. Experimental samples of the 24-inch tube weighed 23 to 28 lb. compared with 34 lb. for similar conventional glass tubes of the same size. It is felt that these lightweight, implosion free tubes may be the answer to the metal cone tubes.

New "Universal" Colour Scanner

A new "universal" colour scanner designed to generate any known colour system has been demonstrated by Telechrome, Inc., at its plant in Amityville, N.Y.

The apparatus is housed in seven racks, employs a flying spot scanner, uses dichroie mirror receiver, contains 900 tubes, can be switched from system to system by push buttons controlling 10 motors. The price is approximately 75,000 dollars.

Television Sets Exported from the U.S.A.

Television sets exported for the 30 weeks of 1952 totalled 41,185 sets.

The breakdown of this export figure being as follows: 22,742 to Cuba; 8,240 to Argentine; 5,545 to Brazil; 1,946 to Mexico; 18 to Italy.

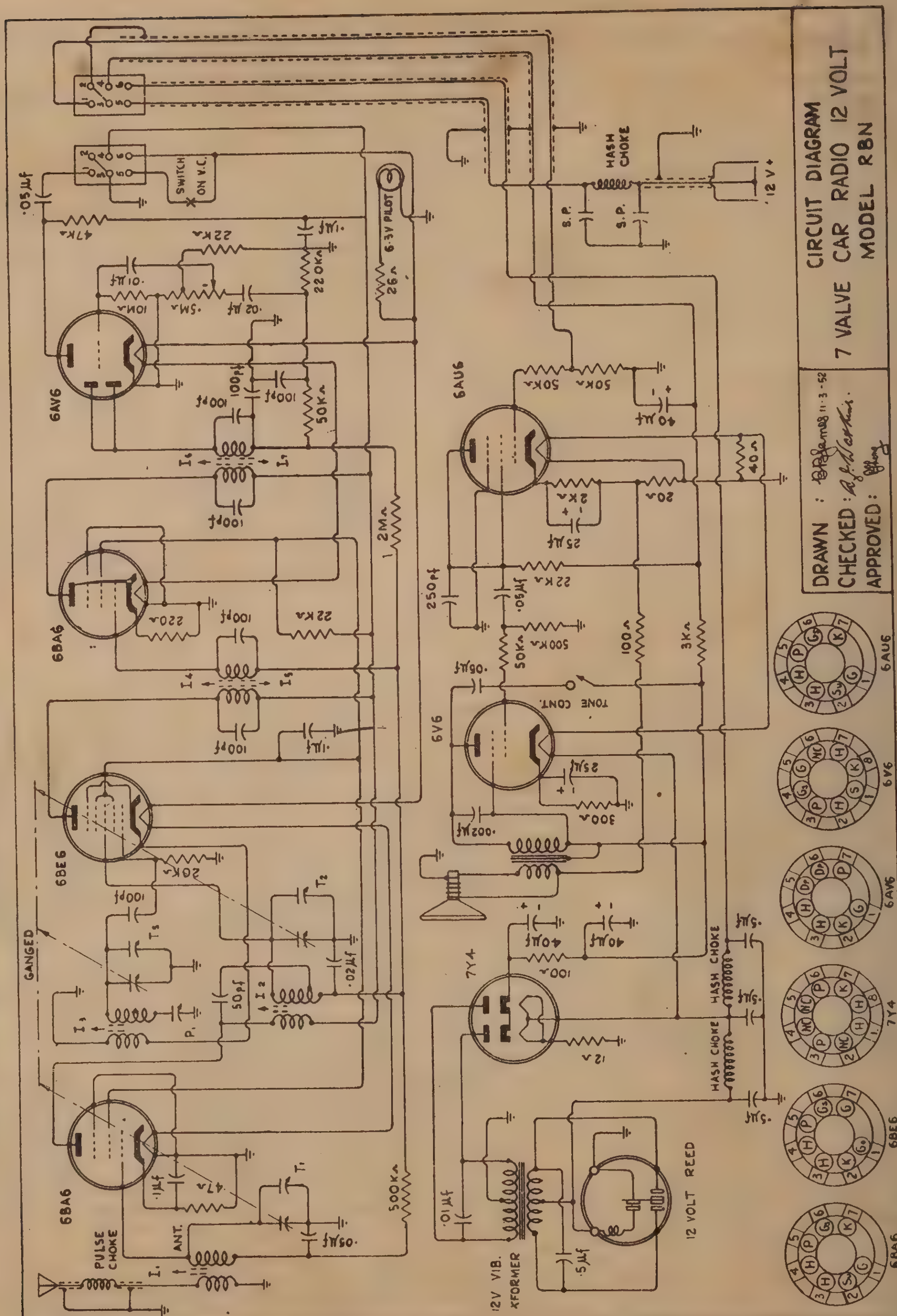
Radio sets exported during the same period totalled 175,339 sets.

Industrial Television—Commercial Model

R.C.A. recently announced the release of its first commercial model of its industrial closed circuit television system, using the Vidicon tube.

The camera uses only three tubes, including the Vidicon and the entire system, consisting of two units, uses 22 tubes.

FOR THE SERVICEMAN—"Ultimate" 7-Valve Car-Radio Model RBN



An Englishman Looks at Television

By J. H. A. WHITEHOUSE

No. 2: TELEVISION AND THE DEALER

What the dealer is concerned with is the difference between television and radio business. Many of the factors which help to sell a radio are not important in television, while others are more so. For example, sensitivity matters only in fringe areas, while sales points like attractive dial scales, bandspread, etcetera, do not exist in TV sets. Quality of audio reproduction, and audio power output have not proved important in TV sets; indeed, most of the mantel sets at home have six-inch speakers, which are often mounted at the side of the cabinet. In TV, selectivity is of no concern where only one station feeds a given area. In selling a television receiver, the dealer can stress the size of the picture, its quality, and colour, bearing in mind that the cinema and still photography have set a high standard in pictorial representation. Bearing in mind that the depth of a television cabinet, from front to back, is almost twice that of a radio set, cabinet work, and such items as doors in front of the viewing tube count more than in ordinary radio.

At Home (and experience in U.K. is far closer to the New Zealand conditions than those in the American area) twelve-inch tubes are still very popular and adequate for ordinary home viewing. That the preference will shift to 14 in. tubes during the next year is probable, mostly owing to the advent of "flat-faced" tubes. Personally, if I were a dealer here, I should avoid stocking sets with round-faced tubes if I could. The other set I would stock would be a 16 in. wide back-projection set. There is an optimum size of picture for viewing under any particular set of conditions; the larger the tube, the worse do picture defects show up, whether these are due to circuit design or to interference. The latter, however, can often be coped with by manipulating the polar diagrams of directional aerials.

Special showroom conditions are not actually necessary, as pictures can be viewed under ordinary lighting conditions. As opposed to radio, home demonstrations on temporary aerials can be very tricky unless the dealer knows his district well, and this might be especially true in some New Zealand cities.

Many dealers have fitted trucks with telescopic masts, often combined with the ladders they normally use for

installation. However, there is a lot to be said for selling from the showroom, if you can.

As against radio, it must be remembered that the TV aerial is part of the set, and that if not properly designed and installed, it can materially affect the picture quality. Multiple outlets in showrooms have to be carefully arranged so that any desired number of sets can be operated at once without difficulty. In Britain, a great deal of aerial installation is done by specialist sub-contractors, if only because dealers simply have not got the time to spend two or three hours on one installation, even if they are being paid for it. There are many tricks in TV aerial work—too many to talk about here. Many jobs are easy, others brutes, sometimes in the same road, or even next door. I would hate to guess what the effect will be on the acres of metal roofs in New Zealand. I know that on the rare occasions on which we struck one at Home, we were usually in for trouble. It looks as if here dipoles will have to be pretty tough to stand up to the winds in some parts of the country.

Most modern sets in Britain are what is known as "5-channel" jobs, which can be installed in any area* by the dealer without any special knowledge or equipment. One trims for the wanted sound channel by ear, and then visually for the best picture, as instructed in the service manual.

**Note.*—The five stations in the U.K. are all on different frequencies, and only one can be received well in any place, so that continuous tuning of the receiver is unnecessary.—Ed.

In the old days, before ion traps and aluminized screens, and when cathodes were not all they might have been, customers and dealers were rightly worried that they might at any time be landed with an expensive tube replacement. Even today, when a tube can have a life of up to three or four years, most of the big operators at Home have some form of service contract to which the customer contributes. This sometimes arranges for a return of payments if all goes well. Some scheme of this kind is worth-while, apart from the tube, for there is a very big difference between a six-valve radio, and a chassis with 17 or 18 tubes, and up to 300 components, from a maintenance angle, especially during the period of hire-purchase.

There is a far wider variety of circuitry in TV sets than in radios. Almost every designer has his pet way, for instance, of pulse generation or synch. separation, and the same thing goes for a large number of circuit functions that have no counterpart in ordinary radio. One hopes that the trade here will not have to service sets which are actually lethal, as we did at Home. Thank heaven, most modern sets use some form of "flyback" E.H.T. generator, which merely throws you through the door instead of killing you!

TV circuits do split themselves up into logical sections, but the serviceman has got to know a great deal more theory unless he is going to waste a lot of time. This knowledge cannot be picked up casually. It has to be learned, and I am glad to hear that the go-ahead New Zealand technical schools are already starting to train personnel. British manufacturers, by running training courses on their models for dealers, made a tremendous

contribution to the standard of knowledge in the trade.

The biggest difference between radio and TV is the use of pulses, and the way in which they are generated, separated and shaped; I do strongly suggest that manufacturers show in their service manuals the pulse shapes that can be expected at various points. It would be a good thing, too, if dealers take a good look at their service equipment. Although, no doubt they will be offered all sorts of wonderful service devices, the picture tube itself will be their best friend, and they will find that a good deal of what they already have will stand them in good stead for TV—if it is in good condition. One thing is, in my view, a "must," and that is a small oscilloscope. Next to that comes a component bridge, to look after the fact that many components in a TV chassis have a 5 per cent. tolerance, and are critical, and to save time that would be spent hunting through a TV set "substituting."

Manufacturers can help their dealers by arranging their chassis in sub-units, notably the R.F. strip, which can be whipped out and replaced in the customer's house, if necessary. Customers do not seem to mind a radio out of action for a day or two, especially if some kind of replacement is available, but if history is going to repeat itself over here, there will be a whale of a howl when the TV goes wrong! It is the dealer who knows his TV, and the manufacturer who gives him a chassis he can service quickly who are going right into the lead, and who will stay there.

TRADE WINDS

Photographed at Paraparaumu Airport prior to his departure on the first leg of his journey overseas is Mr. H. A. L. Lord, Managing Director of Philips Electrical Industries. Mr. Lord is making a business trip of approximately three months' duration to confer with the Philips organization in England and Holland.

The photograph shows, left to right: Messrs. E. Undrill (Factory Manager), R. Slade (Commercial Manager), H. A. L. Lord, and W. G. Culpitt (General Manager, N.Z. Electric Lamp Manufacturers).

RETIREMENT OF MR. C. H. ROSER, ADVERTISING MANAGER, "RADIO AND ELECTRONICS"

There is a gap in our ranks just now, and we miss the cheerful, friendly presence of our former Advertising Manager, Mr. C. H. Roser, known to all as "Charlie." To our great regret, he has left us to seek a well-earned retirement in Levin.

Hailing from the Old Land, Charles arrived in New Zealand in 1921, and immediately joined the staff of the National Electrical and Engineering Co., Ltd., becoming Advertising Manager. In 1935 he was also assigned charge of the newly-established radio section. By this time, of course, he was no stranger to radio, having been associated with Dave Wiles in the organization of Fada battery-operated radios.

Always to the fore in the interests of the trade, he became President of the Wellington Radio Traders' Association in 1938, while his interest in the advertising field was equally keen. As a foundation executive member of the Association of New Zealand Advertisers, he served on the Executive of that many years, and was President in 1947 before leaving for England.

In 1948, on his return from this visit to the Homeland, Mr. Roser joined *Radio and Electronics* as Advertising Manager, becoming one of the most familiar and popular figures on our staff.

We are sure clients and readers alike will join us in wishing Mr. Roser long life and happy retirement in Levin, where we trust that the fishing and gardening will come up to expectations.

RETIREMENT OF MR. R. J. COAKLEY, PRINCIPAL RADIO OFFICER, POST AND TELEGRAPH DEPARTMENT

There is a busman's holiday ahead of Mr. R. J. Coakley, who in January last retired from the position of Principal Radio Officer of the Post and Telegraph Department.

It, too, is a well-deserved retirement after 42 years' service, commencing as a message boy at Petone, and during this time Mr. Coakley has seen radio grow from its infancy to its present highly developed world encirclement. Developments, especially since World War II, have been remarkable in their speed. For example, in New Zealand alone there are 49 V.H.F. channels giving service to 150 operators, with 1357 radio-equipped vehicles—ambulances, fire engines, taxis, etc. In addition to all this, there are 2299 licensed amateur radio operators, 813 other private stations, and 384 Government-controlled stations.

Not from his desk alone has Mr. Coakley participated in this great advance, for he is a keen amateur radio operator, having "worked" 121 countries, 90 of them by radio telephony, and the remainder by Morse key alone.

Now, accompanied by his wife, he is voyaging to England to see the Coronation—and then he hopes to meet many of the amateur radio operators to whom he had been speaking and sending Morse since 1934. From all over Europe, America, and South America have come invitations, and one of his hosts will be Mr. W. J. Erich, a cattle rancher of Lodi, California, who enjoyed a visit to New Zealand last year.

Latest developements in radio and television, both in Britain and in the United States will be the subject of special study by Mr. Coakley, who has also made arrangements to lecture extensively in the United States and show films of New Zealand scenery.

* * *

100 CALCULATIONS A SECOND

It is not a tall story, either! From New York comes the news that the General Electric Company has built a new electric computer capable of making 100 calculations a second, and containing one of the

largest "memories" ever built into such a device. It will be used by the United States Air Force on complex problems of ballistics, aircraft design, and guided missiles.

* * *

Pye/GPL Agreement

An agreement has been signed between Pye Limited of Cambridge, England, and General Precision Laboratory Incorporated, New York, providing for an expanded programme of joint research and development in the field of industrial and broadcast television cameras and studio equipment. The two companies have been associated for three years under an agreement which provided for the development of the items of studio equipment currently marketed by GPL.

A joint statement on the new agreement was issued by Mr. C. O. Stanley, Chairman and Managing Director of Pye Limited, and Mr. Hermann G. Place, President of General Precision Laboratory.

Pye will manufacture cameras and associated studio items in England and General Precision in America, for independent sale through their respective marketing organizations, but the combined engineering knowledge of the two firms, reflecting world-wide operations, will be pooled.

"We think this agreement is important to the entire television industry," Mr. Stanley stated, "because of the unusual scope of experience it brings to a joint development programme.

"Right now," he continued, "GPL image orthicon cameras are in extensive use in networks and independent stations of the United States, Latin America, and Japan. Pye cameras of basically similar design are being used by the British Broadcasting Corporation and in Italy, Switzerland, Germany, and Australia.

"Every bit of operating experience of the two companies goes into this joint development programme," Mr. Stanley said. "Maintaining separate factories provides spares and service equipment on the spot for both American and European markets, but the refinement of commercial television cameras and development of new types will be influenced by the cumulative experience of both companies.

"This agreement means an accelerated development programme never matched before," he added. "The same basic camera designs are being manufactured for use with the various television systems and electrical supply sources used in the many countries to which we are selling, and these problems are a continual challenge to our engineers."

The Pye-GPL agreement mainly covers television cameras, but both Mr. Stanley and Mr. Place said that the two firms are also working closely on theatre television and are planning a similar co-operation in other industrial fields.

Among recent developments of GPL is the highly developed Sibplex Theatre Television System of Direct Projection now used in major theatres across the United States. Thus GPL and other subsidiaries of General Precision Equipment Corporation are adding their television and cinema knowledge to a joint effort to cover Europe.

Proceedings of the New Zealand Electronics Institute Incorporated.

HEADQUARTERS NEWS

At a Council meeting held in the Secretary's office on Tuesday, 27th January, a good volume of business was dealt with, including some matters of considerable importance. The following is drawn from the official minutes, and omits mention of the purely routine business.

Election of President

A letter from the Dunedin Branch put forward the view that the election to the office of President of Mr. Withers, who at the time of the election was not a Council member, was unconstitutional. Mr. Withers himself agreed with this view, and requested Council to take action, as he did not wish to continue in office if his doing so was unconstitutional. After discussion, it was agreed by members of Council that the election of Mr. Withers was quite in accordance with section 21 (1) of the constitution, and on the motion of Mr. Partelow, seconded by Mr. Foster, it was resolved that Mr. Withers continue in office.

Constitutional Amendments

The results of the postal ballot on proposed constitutional amendment were counted, and resulted in the amendments being carried by a large majority. There were five amendments, related to each other, and designed to introduce a new grade of membership, that of Graduate. The proposed amendment, which, having been carried by the ballot, becomes a new rule instituting graduate membership and reads as follows:—

"Graduates"

Every applicant for admission to the grade of Graduate shall be not less than 21 years of age, and shall satisfy the Admissions Committee on one of the following requirements:—

(a) That being a person engaged in electronics work, he has passed the Institute examination for admission to this grade:

(b) That being a person engaged in electronics work he has passed an examination which is acceptable to the Admissions Committee for this grade;

(c) That being without examination qualifications, he has knowledge of the theory and applications of electronic science of a standard acceptable to the Admissions Committee for this grade.

Since the carrying of this amendment necessitates modifications to the rules concerning other grades of membership, the remaining four amendments were by way of machinery only, and were also carried.

Two further amendments were concerned with making the immediate past President of the Institute an ex officio member of the Council. The first amendment simply increases the membership of the Council by one, while the second establishes a new rule along the lines indicated. Both were carried.

For some time past there has been a feeling that the Institute fees were too high, and that this was due to the provision for distributing *Radio and Electronics* to the membership of the Institute. Since this was a matter that concerned all members, corporate or otherwise, Council had felt that although only corporate members, by the constitution, are entitled to a vote, the whole membership should be given an opportunity of expressing its views. Accordingly a poll was taken, with the following results.

(1) Continue with *Radio and Electronics* as the official organ of the Institute at the present subscription rates.

Voting.—Ayes, 15; Noes, 44; Informal, 3.

(2) Reduce present rates by making *Radio and Electronics* voluntary.

Voting.—Ayes, 48; Noes, 10; Informal, 3.

(3) Would you subscribe to *Radio and Electronics* if on a voluntary basis?

Voting.—Ayes, 35; Noes, 22; Informal, 4.

After the results of these two polls were declared, it was resolved that the Secretary be authorized to take all necessary legal steps to incorporate the constitutional amendments and additions to the existing constitution.

With regard to the poll concerning *Radio and Electronics*, it was resolved that the matter be put to a vote of corporate members.

Remit from Christchurch Branch re Transfer of Headquarters

The wording of the remit was as follows:

"In the constitution of the N.Z.E.I. provision was made so that Council could be located in any centre. This Branch considers that the time is now opportune for Council to be located in Dunedin."

Mr. Symmons advised that the transfer of headquarters to Dunedin would entail certain practical difficulties, and Mr. Shiel also informed the meeting that so far they had not been able to locate a suitable secretary. The present Dominion Secretary then requested that he be released from duties immediately, but after further consideration, and on the condition that N.Z.E.I. work would not receive top priority, he agreed to continue in office until the end of the current financial year.

Outstanding Subscriptions

It was resolved, after some discussion, "That the Secretary take the necessary action and advise all unfinancial members that their membership had now lapsed, but could be reinstated under Section 8 (f), provided payment of all outstanding dues was received promptly, and that the result of the questionnaire on *Radio and Electronics* be covered in the Secretary's letter to all unfinancial members."

Institute Examination

The question of the Institute Examination was discussed by the meeting at some length, the general feeling being that steps should be taken to revise the syllabus according to present-day requirements. Accordingly, the following resolution was carried:—

"That the Board of Examiners be reconstituted, and be asked to give immediate consideration to the production of a report covering the recognition of the Institute syllabus in the first instance."

The following committee was then set up to compile the report: Convener, Mr. Pollard; other members, Messrs. Partelow and Withers.

Wellington Branch Television Project

The first meeting of the TV Committee was held on Tuesday, 10th February, and considerable progress was made towards the starting of actual construction. By the next Branch meeting, the Committee hoped to report that sufficient equipment had been donated to enable a start to be made on the actual construction of the synchronizing unit for the transmitter.

It was decided that in order to save considerable time that would have to be spent in detailed design work, the Branch project should make use of the detailed design for a synchronizing unit currently being published in serial form in *Radio and Electronics*. Also, in order that progress might be accelerated, various members of the TV Committee should make themselves responsible for the detailed design of various units of the complete programme. It was very desirable that construction should start as soon as possible, because the Wellington Technical College, which had so generously provided facilities for carrying out the work of building the equipment, was about to start a course in television, and the Committee felt that it was essential for the project to have made some physical progress before the College's course of lectures commenced.

Since the volume of work to be carried out will be great, it was decided that there would certainly be more constructional work available than would be needed to keep Branch members themselves occupied. Consequently, at a later date, an invitation would be issued to all those engaged in radio or electronic work, whether members of the Institute or not, to participate in the work of assembling the equipment. Those who may wish to avail themselves of this opportunity are therefore asked to contact the Chairman of the TV Committee, Mr. W. D. Foster, either by telephone or by letter, to P.O. Box 8022, Wellington, or telephone 70,216, Wellington. Mr. Foster volunteered to take down the necessary particulars and communicate with applicants in the near future, when work is to be started.

"Radiotron Designers' Handbook"

After reading our review of the "Radiotron Designers' Handbook" published in our January, 1953, number, the Editor of the former, Mr. F. Langford-Smith, has been kind enough to favour us with an explanation of certain of the omissions on which we remarked. We feel sure that his comments will be of interest to readers, and therefore take the liberty of publishing them hereunder:—

"Tape recording was omitted, purposely, for a number of reasons. Firstly, the book is already quite large enough, and this would have added another 15 pages or so. Secondly, it is not yet being used in the home as a serious competitor to discs, and I very much doubt whether it ever will be.

"One of my reasons for this statement is that it is unsuited for selected short musical items which form the vast majority of ordinary musical listening—for which application discs are ideal. Its use for symphonic and other long works is obviously limited. It will also have a limited use for home recording and reproduction, but the high first cost of the equipment is a serious deterrent.

"With regard to the other criticism concerning the concentration of attention to domestic radio receivers (A.M. and F.M.) communications receivers are fairly well covered with aerial input pages 912–921, design of, (A.M.), 1260–1264, A.V.C. circuit design 1108, 1116, band-spreading 1253–1256, band-changing 1261, bass attenuation 649, beat frequency oscillator 954, 960–961, cross-modulation 1264, diversity reception 1263–1264, frequency coverage and calibration 1260–1261, muting 1125, noise limiting 694–699, 1130–1132, selectivity 1262, methods of measuring sensitivity and noise 1262, signal strength (S) meter 1263, frequency stability 1262, variable bandwidth crystal filters 1051–1061, volume control and A.V.C. 1262–1263, F.M. mobile, limiters for, 1149–1150, whistle filters 673-676. In addition, many of the general features of Chapters 23 to 29, 35 and 36 are applicable.

"'Ham' receivers follow most of the general principles of communication receivers, except that they are less elaborate, and the design details listed above may be used, where applicable. The mechanical arrangement and layout which form important features of the design, are obviously outside the scope of a book such as the R.D.H., but are well covered by the amateur literature."

Index to "Radio and Electronics," Volume 7

Abstract Service

(Continued from Page 27.)

repetition of the signal over and over again; there is also the theory of inverse probability and these have been valuable in stimulating original thought in relation to propagation.

—*Wireless World* (Eng.), November, 1952, p. 445.

A review of amplitude modulation, which is easily the most commonly used method for transmission, and its correct use is vital for the best results. The article forms a valuable review for students or amateur transmitters.

—*Radio and Hobbies* (Aust.), January, 1953, p. 33.

TELEVISION

For the first time in history, seven transmitters, working on three different standards and covering three countries (France, Britain, and Belgium) were linked together to telecast the same international programmes for a full week, ending on the French national day. Between Lille and London a chain of four microwave repeaters was set up and went straight across the channel. There has been the problem of conversion from the Continental to the British line system. This is effected by displaying a good 819-line system which is then picked up by a 441-line camera and this did not prove too difficult. Details of the full broadcast system are given.

—*Radio and Television News* (U.S.A.), December, 1952, p. 31.

The dread of every radio technician is the set that plays only intermittently: hints given on combatting the most time-consuming and annoying service problem—localizing the defect; types of intermittents; mechanical and thermal intermittents; humidity intermittents and means of correcting them.

—*Ibid*, p. 134.

Denver, in the U.S.A., was left without a television station and became the centre of a group of television DX-ers. The secret seems to be making the very best use of aerial systems to pick up all that can possibly be caught in favourable conditions, with very useful practical experience to be gained.

—*Ibid*, p. 53.

TRANSMITTERS AND TRANSMITTING

Details given of conversion of a war-surplus instrument. This was an MN-26Y with which radio mechanics may well be familiar. A power supply was added and the necessary adjustments made to complete the receiver and transmitter, all apparently at very low cost.

—*QST* (U.S A.), December, 1952, p. 15.

MISCELLANEOUS

Beats: the visible and audible effects when two frequencies are combined. This is written for the student who wishes a better understanding of the heterodyning process, divorced from mathematics.

—*Wireless World* (Eng.), November, 1952, p. 152.

Tube Data

(Continued from Page 29.)

Limiting Values

Anode voltage	V_a	= max.	150 V
Anode dissipation	W_a	= max.	3 W
Cathode current	I_k	= max.	20 mA[1]
Grid current	I_g	= max.	5 mA
Grid current starting point	V_g (I_g = +0.3 μA)	= max.	—0.2 V
External resistance between grid and cathode	R_g	= max.	1 MΩ

[1]Absolute maximum. When operating the tube with this cathode current, the filament voltage must be at least 1.1 volts.

The DC80 is provided with the standard noval base; the material of the socket must answer high requirements. The Philips socket type 5908/03 is recommended for this use. At the highest frequencies, however, the tube must be used without socket.

The small dimensions, and battery operation, make the DC80 especially suitable for use in portable equipment. The tube can be mounted in all positions.

Philips Experimenter

(Continued from Page 27.)

the modulation choke and dropping resistor on C.W., while S_{3e} disconnects the screen of the modulator from H.T. in the C.W. position, preventing the EL41 from drawing any current.

Both S_2 and S_3 are P. & T. type lever-type switches, obtained from war-surplus sources, namely from the remote-control units of ZC1s, or separately as spares for these. They are very compact, and in the receiver are mounted above the chassis. All the leads coming through the chassis to them carry only D.C. or audio voltages, and no difficulty will be encountered with feed-back effects as long as reasonable precautions are taken to see that leads say, to S_{3d}, which are at a high audio potential, do not run close to those concerned with S_{2a}, which carries audio at an earlier stage.

It will be noted that separate audio gain controls are provided for the modulator and the receiver, this again in the interests of operating convenience, as it is very awkward having to adjust the gain control every time one switches from Receiver to Transmit, or vice-versa, which has to be done if only one audio gain control is used.

Some builders may wish to operate the modulator tube as an output stage in the Receive position, and there is nothing against this as long as the power supply can take care of the additional current drain. If it is desired to do this, some modifications to the switching will be needed. An ordinary output transformer can be used to replace the modulation choke, as long as the secondary is open-circuited to remove the speaker load on "Transmit." In this way, the primary of the transformer is used as a choke for modulation purposes. The switch section shown as S_{3e} would not be needed, as the modulator would be required to run at all times. Similarly, S_{2c} would need to switch only the receiver H.T., but an extra section would be needed on S_2 to take care of the output transformer secondary.

The letters on the diagram refer to the corresponding ones on the transmitter circuit diagram. B goes to the final amplifier, A to the oscillator, C to the aerial section of the relay contacts, D to the aerial, as shown on the transmitter circuit diagram, and E to the final filament.

Synch. Signal Generator

(Continued from Page 31.)

At this stage it is convenient to examine the part played by V_3. This is an EB91, or 6AL5, with the sections strapped in parallel. The cathode is connected to the 20k. resistor of the differentiating circuit, while the plate is tied to the plate of V_{4a}. It must be remembered that between triggering pulses, V_{4a} is cut off, so that its plate is at the potential of the H.T. line. Thus, both cathode and plate of V_3 are at the same potential, and no current flows through it. When a positive pulse arrives, this makes the cathode of the diode more positive than its plate, thereby cutting it off, and preventing the positive pulses from being passed on to the flip-flop. When a negative pulse arrives, however, the cathode of V_3 is driven negative with respect to its plate, and the diode conducts. It thus acts as though it were merely a resistor of a few hundred ohms, and the negative pulse is applied to the plate of V_{4a}. It has no direct effect on V_{4a} itself, but is passed by the coupling condenser, to the grid of V_{4b}, where it triggers the flip-flop in the manner already described. The values in the flip-flop are so chosen that on the arrival of the next negative pulse, the circuit has not yet recovered, so that the first pulse after it has triggered has no effect. The circuit then returns to its stable state before the next negative pulse comes along, and it is triggered again, giving a waveform as depicted in Fig. 3 (c).

The waveform at the plate of V_{4a} is similar to that shown for V_{4b} turned upside down, or, in other words, reversed in polarity. During the unstable condition, therefore, the plate of V_3 travels towards earth along with the plate of V_{4a}, to which it is connected, so that the diode is firmly cut off while the flip-flop is in the unstable state. The diode therefore acts as a buffer, preventing the violent voltage changes at the plate of V_{4a} from reacting back on the master oscillator. In addition, it prevents the positive pulses which are made by the differentiating circuit at the same time as the negative ones, from reaching the flip-flop.

(To be continued.)

Saw-Tooth Generator

(Continued from Page 7.)

One feature of this time-base not possessed by many others is the facility with which it can be converted into a triggered instead of a free-running one. To do this, it is only necessary to make a slight increase in the value of the cathode resistor, so that the oscillation just stops. Then, when a large enough input voltage is applied to the synch. terminal, the time-base will be triggered off; unless another synchronizing impulse is provided, the time-base will execute one sweep, and then stop. If this feature is required, the value of additional cathode resistance can easily be found by measuring the existing resistance in the cathode circuit, re-adjusting the variable resistor until the oscillation stops, and then measuring the resistance again. The added resistance can then be inserted as an additional fixed resistor, provided with a single-pole switch which will short-circuit the extra resistor unless it is depressed. This switch could be placed on the front panel of the 'scope, and labelled appropriately.

The very heavy bypassing of the cathode resistor of the 6AC7 is important if the best linearity is to be obtained. It might be thought that leaving the cathode resistor completely unbypassed, would improve the linearity on account of the negative feedback introduced into the Miller tube. Such is not the case, however, because doing so reduces the amplification more than it increases the linear response of the valve, and the overall result is that the saw-tooth linearity deteriorates instead of improving. Accordingly, it is found that at very low frequencies, a worth-while improvement in linearity results if a larger-than-usual cathode bypass condenser is used. Hence the 100 $\mu\mu$f., which can be made up from two 50 $\mu\mu$f. units in parallel.

Another important point that does not emphasize itself on the circuit diagram is the use of the decoupling network in the plate circuit of the multivibrator. This gives appreciably more filtering than is needed for straight amplifier circuits, and this is found to be essential if satisfactory high-frequency performance is to be obtained. The trouble is that if any hum voltage is present in the H.T. supply to the MV, it modulates the output very slightly. At low frequencies, the extent of this modulation is too slight to have any observable effect, but at high frequencies, the result is that successive time-base sweeps do not start from the same point on the C.R.T., giving the same effect as if considerable hum were applied directly to the X plates.